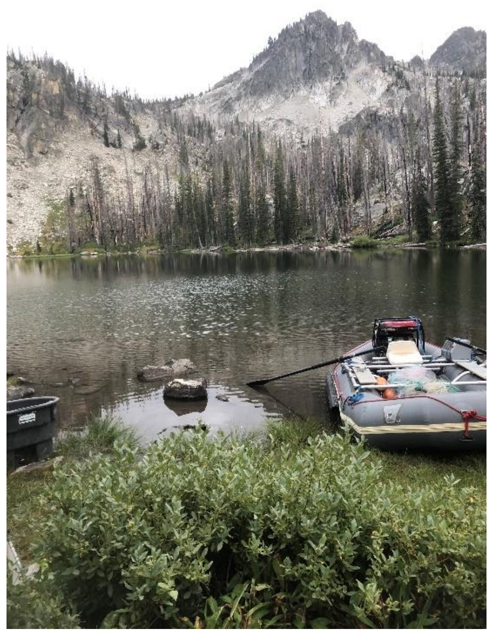
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME
FISHERIES MANAGEMENT ANNUAL REPORT

Ed Schriever, Director

SALMON REGION 2019



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HIGH MOUNTAIN LAKE STOCKING AND SURVEYS

ABSTRACT

Salmon Region fisheries staff coordinated with Mackay Fish Hatchery and Sawtooth Flying Service to stock 39,396 fish across 57 high mountain lakes in the Salmon Region in 2019. A total of 41 lakes were stocked with 30,121 Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi*, seven lakes with 5,291 triploid Rainbow Trout *O. mykiss*, four lakes with 1,456 Arctic Grayling *Thymallus arcticus*, and five lakes with 2,528 Golden Trout *O. mykiss aguabonita.* Aerial stocking took place between August 20 and August 31, 2019. Flight costs totaled $7,790 for 2019.

In 2019, fisheries staff surveyed five high mountain lakes to evaluate growth, survival, and relative abundance of trout stocked in these lakes. Lakes were selected based on perceived high public use and lack of recent survey data. Amphibians were observed at four of the five lakes surveyed. Similarly, three of the five lakes surveyed had fish present. The gillnet catch rate ranged from 0.3 to 2.2 fish/h.

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INTRODUCTION

Anglers fishing high mountain lakes in Idaho have consistently expressed high satisfaction with their experience (IDFG 2019). High mountain lakes offer diverse angling opportunities in highly scenic areas and are an important contributor to the state's recreational economy. Stocking hatchery trout plays a vital role in managing angling opportunities in mountain lakes. Of over 1,000 Salmon Region high mountain lakes, 189 are currently being stocked on a three-year rotation, and four are stocked every year. Idaho Department of Fish and Game (IDFG) primarily stocks four species of fry (TL <76 mm) in high mountain lakes: Arctic Grayling *Thymallus arcticus* (GRA), Golden Trout *Oncorhynchus aguabonita* (GNT), triploid Rainbow Trout *O. mykiss* (RBT), or Westslope Cutthroat Trout *O. clarkii* (WCT) fry. In rare circumstances, IDFG also periodically stocks predator species such as tiger muskellunge *Esox masquinongy x E. lucius*, or tiger trout *Salmo trutta x Salvelinus fontinalis* (BB) in some high mountain lakes to reduce abundance of other fish species (i.e. Brook Trout, BKT). The three-year stocking rotation maintains a diverse size structure of fish and ensures fish populations persist in mountain lakes where natural reproduction is not sufficient. The stocking rotation list is adjusted annually to reflect up-to-date survey information and current management goals.

OBJECTIVES

Mountain Lake Stocking

1. Provide diverse high mountain lake fisheries throughout the Salmon Region (i.e. diverse species and size structure), with emphasis placed on high-use areas where natural reproduction does not occur.

Mountain Lake Surveys

1. Assess fish growth and relative abundance in stocked high mountain lakes.

2. Identify high mountain lakes that currently support naturally-reproducing fish populations, and determine whether natural reproduction is adequate for maintaining quality fisheries.

3. Gather current fish community data to inform management of high lake fisheries and provide accurate fish population information to anglers.

4. Gather information on amphibian presence or absence.

STUDY AREA

The Salmon Region contains more than 1,000 high mountain lakes. These range from small ponds that are less than one hectare in size to 70-ha Sawtooth Lake #1 in the Stanley Basin. Regional high mountain lake elevations range from 1,970 m to over 3,000 m. Further information on each specific lake that was surveyed in 2019 can be found in the results section of this chapter.

METHODS

Mountain Lake Stocking

One-hundred and ninety one (191) high mountain lakes throughout the Salmon Region are currently stocked on a three-year rotation. Stocking decisions change based on the newest data available from our most recent high mountain lake surveys. The stocking program helps maintain fish populations in high mountain lakes that could not otherwise support a fishery (i.e. lack of natural reproduction).

High mountain lake stocking densities and species requests are coordinated between regional staff and Mackay Fish Hatchery staff each spring. Fish are hatched and reared at Mackay Fish Hatchery, who coordinates with the contracting aviation company (Sawtooth Flying Service, McCall, ID) to stock the lakes with the correct species and number. As of September 2016, 58 lakes are requested to be stocked on rotation A, 76 lakes on rotation B, and 57 lakes on rotation C. Actual stocking can vary from the request in some years, due to a surplus or deficit in fish, or to accomplish specific management objectives. Rotation C lakes were requested to be stocked in 2019 (Table 1). Each stocking rotation usually requires multiple flights and/or days to complete all stocking for one rotation. Flight routes for each rotation were refined in recent years to keep flight time and fuel costs efficient. Further details of regional aerial stocking methodology were reported in Flinders et al. (2013).

Mountain Lake Surveys

Typically, fish are sampled using one sinking and one floating mountain lake gillnet fished overnight. Lakes that were deemed too shallow to support fish were not netted. Monofilament gill nets were 36-m long by 1.8-m deep, and composed of six panels of 10.0-, 12.5-, 18.5-, 25.0-, 33.0-, and 38.0-mm mesh. Captured fish were enumerated, measured to the nearest mm total length (TL) and weighed in grams (g). Length-frequency histograms were constructed and calculated mean TL (± standard error; SE) for each species at each lake to describe size structure. Relative abundance (catch-per-unit-effort, CPUE) was calculated as the total number of fish caught, divided by the total number of gillnet hours (fish/h). Relative weights (W_r) were calculated for fish larger than 130 mm TL using the standard weight (W_s) equation:

$$Log_{10}(W_s) = a + b * \ Log_{10}(\text{total length (mm)})$$

Where *a* = the intercept value and *b* = slope derived from Blackwell et al. (2000). The log value is then converted back to base 10, and relative weight is then calculated using the equation:

$$W_r = \left(\frac{\text{weight (g)}}{W_s}\right) * 100$$

At each lake, we assessed presence and relative abundance of amphibians using a modification of the timed visual encounter survey (VES) (Crump and Scott 1994). The main deviation from the VES methodology was that the survey crew performed a full perimeter search without accounting for various habitat types. Survey data was entered into the statewide ‘Lakes and Reservoirs’ database.

RESULTS AND DISCUSSION

Mountain Lake Stocking

Aerial stocking in fifty-seven lakes took place between August 8 and August 27, 2019. Flight costs totaled $7,790.00 for 2019, equating to roughly $137 per lake. In total, 41 lakes were stocked with 30,121 WCT, 7 lakes with 5,291 triploid RBT, 4 lakes with 1,456 GRA, and 5 lakes with 2,528 GNT (Table 1).

Mountain Lake Surveys

Due to time and personnel constraints, only five lakes were sampled during the summer of 2019. The Mable chain of lakes near Cape Horn, ID were sampled as well as Martha Lake near Stanley Lake, ID.

Mable Lake #1

No gillnet was set at Mable Lake #1. Mable Lake #1 appeared to be fishless and extremely warm. The surface water temperature was 21° C at 14:00. During the amphibian survey, all life stages of Western Toad were observed with no other species being observed. There appeared to be little to no recreational use of the lake.

Mable Lake #2

Thirty-one BKT were captured in the sinking gillnet (CPUE = 2.2 fish/h) and 2 BKT were captured in the floating gillnet (CPUE = 0.1 fish/h; combined CPUE = 1.1 fish/h). The total length of BKT ranged from 131 to 323 mm with a mean TL (± SE) of 232.8 mm (± 11.9). Average relative weight (W_r) was 63.1 (range = 36-90) (Table 1; Figure 1). Mable Lake #2 has not been stocked with any fish since 1993 when RBT were last stocked. Our survey suggested that Mable Lake #2 receives little to no use, although it is relatively close to the Seafoam Road (4.2-km hike x-country). This was the first recorded survey of Mable Lake #2. No amphibians were observed. We do not recommend any management changes to Mable Lake #2

Mable Lake #3

One sinking and one floating gillnet were set at Mable Lake #3 near the inlet for 17.8 and 17.5 hours, respectively. The total length of BKT ranged from 125 to 298 mm and averaged 207.7 mm (± 5.5). Thirty-one BKT were sampled via the sinking gillnet (CPUE = 1.8 fish/h) and 19 BKT were sampled via the floating net (CPUE = 1.1 fish/h; combined CPUE = 1.4 fish/h). Average relative weight (W_r) was 73.7 (range = 54-89) (Figure 1; Table 2). Golden Trout were stocked into Mable #3 in 2018 and none were observed. Mable Lake #3 had not been surveyed since 1992. No amphibians were observed. We recommend taking Mable #3 out of any stocking rotation.

Mable Lake #4

No gillnet was set Mable Lake #4 and no fish were observed. It was determined the lake was likely too shallow to support fish. Columbia Spotted Frog was observed. There appeared to be a low level of recreational use of the lake, despite its close proximity to the Halsted trail.

Martha Lake

One floating gillnet was set in Martha Lake for 13.5 hours and caught four WCT (CPUE = 0.3 fish/h). Total length (TL) of WCT ranged from 209 to 232 mm and averaged 226 mm (SE ± 5.7 mm). Average relative weight (W_r) was 92.5 (range = 89-97) (Figure 1; Table 2). Martha Lake is on the "B" stocking rotation for high mountain lakes and last received fish in 2018. Use appears to be very low, likely due to the unmaintained trail. Fishing access around the lake is also extremely difficult due to the amount of deadfall. Martha Lake was last surveyed in 2000. We do not recommend any changes to stocking at this time, however the Forest Service should be contacted to put the trail on the list for maintenance. We would expect Martha Lake to see much higher use due to its proximity to the trailhead and relatively easy hiking conditions (1.83 km and 30 m elevation gain). We also observed adult and juvenile Columbia Spotted Frog during our amphibian survey of Martha Lake.

MANAGEMENT RECOMMENDATIONS

1. Remove Mable Lake #3 from the stocking rotation.

2. Work with Forest Service to recommend trails for maintenance to promote access to lakes.

Table 1. High Mountain Lakes stocked in the Salmon Region in 2019 (Rotation C). Species stocked include Rainbow Trout (RBT), Grayling (GRA), Golden Trout (GNT), and Westslope Cutthroat Trout (WCT).

Date stocked	Lake	Species	Number stocked
8/31/2019	Basin Creek Lake	WCT	1,133
8/31/2019	Bear Valley #1	GRA	461
8/31/2019	Bear Valley #1	WCT	1,511
8/20/2019	Birdbill	WCT	495
8/31/2019	Bronco	WCT	728
8/20/2019	Cabin Creek #3	WCT	110
8/20/2019	Cabin Creek #4	WCT	605
8/20/2019	Cabin Creek #7	WCT	302
8/20/2019	Cabin Creek Peak #1	WCT	247
8/31/2019	Crater	GNT	708
8/31/2019	Devils	WCT	351
8/20/2019	Finger #3 (Fall Creek #3)	WCT	481
8/31/2019	Glacier	GNT	283
8/31/2019	Golden Trout	GNT	951
8/31/2019	Gooseneck	GNT	202
8/20/2019	Harbor	WCT	3,009
8/20/2019	Heart	WCT	1,676
9/20/2019	Helen	WCT	1,096
8/31/2019	Hidden	WCT	1,119
9/4/2019	Hindman #1	WCT	497
8/31/2019	Knapp #14	GRA	249
8/20/2019	Knapp #7	WCT	206
8/31/2019	Line	WCT	351
8/27/2019	Lola #2	WCT	500
8/27/2019	Lola #3	WCT	500
8/20/2019	Loon Creek #11	WCT	371
8/20/2019	Loon Creek #13	WCT	220
8/20/2019	Loon Creek #3 (Fish)	WCT	151
8/23/2019	Lost Packer	RBT	1002
8/31/2019	McNutt (Basin Creek #4)	WCT	418
8/31/2019	Hat Creek #1	GRA	249
8/31/2019	Hat Creek #2	GRA	497
8/23/2019	Hat Creek #3	RBT	995
8/23/2019	Hat Creek #4	RBT	299
8/31/2019	NFEF Reynolds #2	WCT	1,295
8/31/2019	NFEF Reynolds #4	WCT	998

Table 1 (continued)

Date stocked	Lake	Species	Number stocked
8/20/2019	Paragon	WCT	275
8/31/2019	Pass	GNT	384
8/31/2019	Pass	WCT	297
8/31/2019	Patterson #1	WCT	148
8/31/2019	Patterson #3	WCT	135
8/23/2019	Puddin Mountain #1 (Buck)	RBT	497
8/20/2019	Puddin Mountain #10 (Turquoise)	WCT	275
8/20/2015	Puddin Mountain #15 (Skyhigh)	WCT	673
8/23/2019	Puddin Mountain #2 (Doe)	RBT	501
8/23/2019	Puddin Mountain #5 (Reflection)	RBT	995
8/23/2019	Puddin Mountain #6 (Twin Cove)	RBT	1,002
8/20/2019	Ramshorn	WCT	344
8/20/2019	Rocky	WCT	962
8/20/2019	Ship Island #5 (Airplane)	WCT	1,003
8/20/2019	Ship Island #7 (Sheepeater)	WCT	330
8/20/2019	Spruce Gulch	WCT	1,456
8/20/2019	Tango #4	WCT	673
8/20/2019	Tango #6	WCT	907
8/31/2019	U.P.	WCT	2,047
8/20/2019	Welcome	WCT	1,223
8/20/2019	Wilson	WCT	1,003

Table 2. Fish presence and gillnet catch per unit effort in high mountain lakes surveyed in 2019, including current stocking information, fish species, mean total length (TL), and whether or not amphibians were observed. RBT= Rainbow Trout, GDT= Golden Trout, BKT= Brook Trout, WCT=Western Cutthroat Trout

Lake name	Year last stocked	Species last stocked	Fish species present	Number caught	Gill net CPUE (fish/h)	Mean TL (mm) (range)	Amphibians (Y/N)
Mable Lake #1	1993	RBT	None	0	0.0	-	Y
Mable Lake #2	1993	RBT	BKT	33	1.1	232.8 (131-323)	N
Mable Lake #3	2018	GDT	BKT	50	1.4	207.7 (125-298)	Y
Mable Lake #4	Never	-	None	0	0.0	-	Y
Martha Lake	2018	WCT	WCT	4	0.3	226.0 (209-233)	Y

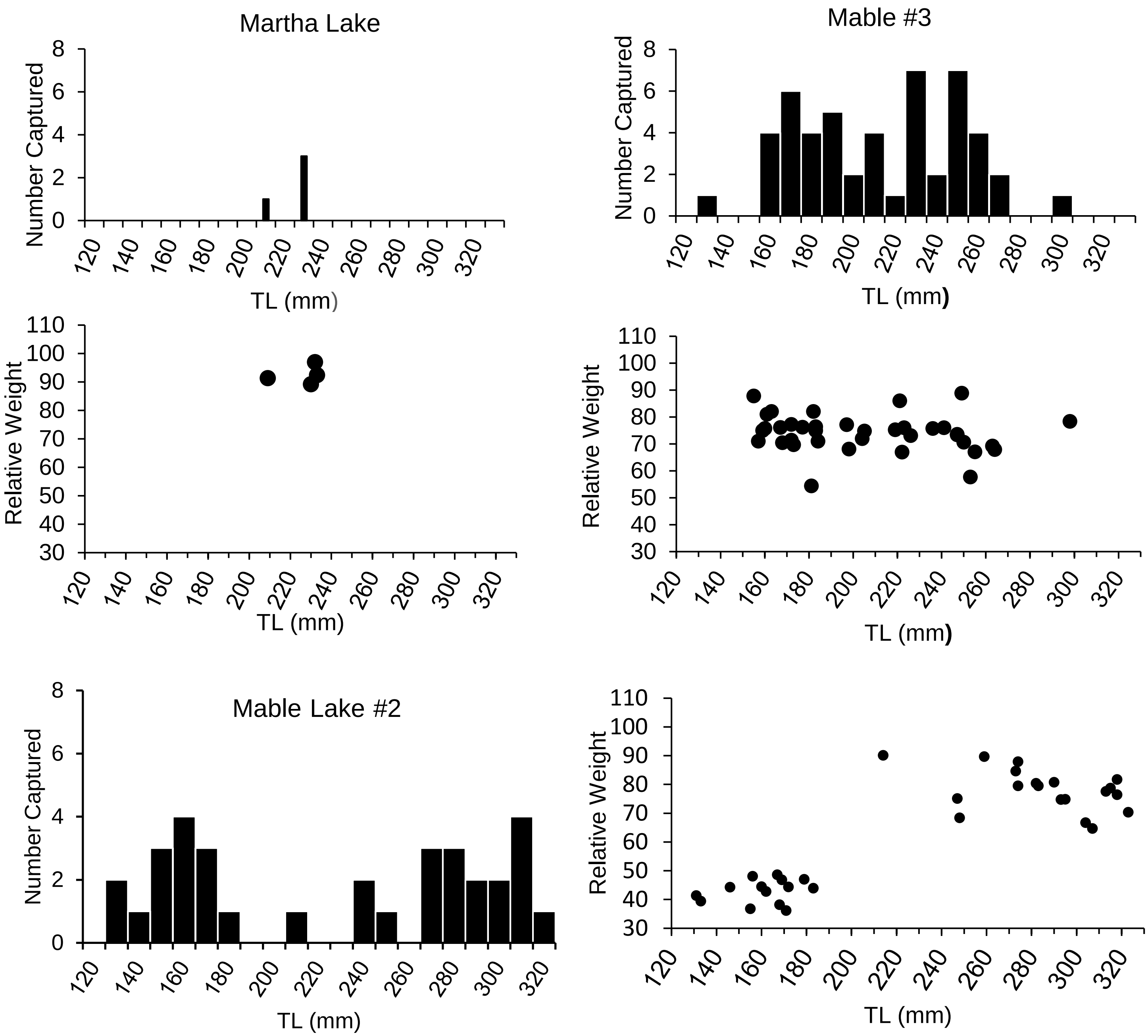

Figure 1. Length-frequency histograms and distribution of relative weights for all fish gillnetted from Martha Lake, Mable Lake #3 and Mable Lake #2 in the Salmon Region in 2019.

LOWLAND LAKES AND RESERVOIRS:

LAKE INVENTORIES

ABSTRACT

As part of Salmon Region lowland lake management efforts in 2019, we sampled Big Bayhorse, Little Bayhorse, Buster, Yellow Jacket, Iron, and Wallace lakes. All lakes were sampled with overnight sets of paired IDFG standard lowland lake gillnets, except for Wallace Lake where only sampling for Redside Shiners *Richardsonius balteatus* occurred. Catch-per-unit-effort ranged from 0.59 fish/h at Iron Lake to 1.06 fish/h at Yellow Jacket Lake. Angling catch rates during sampling were above 1 fish/h at all lakes except for Buster Lake and Little Bayhorse (not angled). Mean relative weight for Westslope Cutthroat Trout *Oncorhynchus clarkii* and Rainbow Trout *O. mykiss* ranged from 74-81 and 74-87, respectively. Current stocking regimes appear to be sufficient for all lakes surveyed in 2019. Westslope Cutthroat Trout should be stocked at 1,700 fingerlings/hectare at Little Bayhorse Lake annually to continue to provide a diverse fishing opportunity in the region.

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INTRODUCTION

The Salmon Region defines lowland lakes as being generally accessible by road and able to be stocked with fish by truck. There are 23 lowland lakes, 2 reservoirs, and 11 public ponds in the Salmon Region (Curet et al. 2011). Fisheries management objectives for lowland lakes in the Salmon Region focus on providing diverse angling opportunities (i.e. species diversity), with angling catch rates above 1 fish/h, and diverse size structure, including opportunity for trophy-size fish when possible. Understanding fish species composition, relative abundance, and size structure is an important part of managing these fisheries, and helps us evaluate whether those fisheries are meeting objectives, and if not, determine strategies to improve them.

OBJECTIVES

1. Evaluate growth of Westslope Cutthroat *Oncorhynchus clarkii* fingerlings stocked in Big and Little Bayhorse Lakes in September 2015 and October 2018.

2. Determine the species composition, relative abundance, and size structure of the fish population in Buster, Iron, and Yellow Jacket lakes.

3. Evaluate effect of stocking of tiger trout on the Redside Shiner *Richardsonius balteatus* population in Wallace Lake.

STUDY SITES AND METHODS

Lowland lake standard gillnetting took place at all study lakes except Wallace Lake. Standard experimental gillnets were set in a pair consisting of floating and sinking net with the smallest mesh of both nets set nearest to shore. Net dimensions were 46-m long x 2-m deep, with six panels consisting of 19-, 25-, 32-, 38-, 51-, and 64-mm bar mesh. Nets were set perpendicular to the shore. Fish caught were identified to species, enumerated, measured (mm TL), and weighed (g), and otoliths were extracted for ageing. We constructed length-frequency histograms to describe overall size structure, and relative abundance (catch-per-unit-effort, CPUE) was calculated as the total number of fish caught, divided by the total number of gillnet hours. We also angled at lakes to assess angler catch rates calculated in fish caught/hour. Otoliths were stored, dry, in vials at the Salmon Regional office for future use, but were not analyzed for this evaluation. Relative weight (W_r) was calculated using the standard weight formula (W_s):

$$Log_{10}(W_s) = a + b * \ Log_{10}(\text{total length (mm)})$$

Where a = the intercept value and b = slope derived from Blackwell et al. (2000), and then converting back to base 10 to solve for W_r:

$$W_r = \left(\frac{\text{weight (g)}}{W_s}\right) * 100$$

Redside Shiner were trapped on two occasions at Wallace Lake in 2019. Redside Shiner trapping in 2019 followed the same methods outlined in the 2014 IDFG Salmon Region Annual Report (Messner et al. 2016). Trapping occurred on June 12 and July 23. We used one-way

ANOVA (α = 0.05) to test for differences in trap cluster CPUE (fish/min) for years 2018 and 2019 for June and July and conducted pairwise comparisons using post-hoc Tukey's test to determine significant differences in overall CPUE between years and between months.

Bayhorse Lakes

Big Bayhorse Lake (WGS84 datum: 44.41307º N, -114.40231º W) is 7.5 ha in surface area and sits at 2,621 m in elevation in the Bayhorse Creek drainage (tributary of the Salmon River) south of Challis. Little Bayhorse Lake (WGS84 datum: 44.41245º N, -114.39004º W) is 6.5 ha and sits 1 km to the east of Big Bayhorse Lake, at an elevation of 2,541 m. From Challis, the drive to Bayhorse Lakes is approximately 30 km in total; the last 12 km of which are on a narrow, steep dirt road that winds past the ghost town of Bayhorse (now a state park). While Little Bayhorse Lake offers dispersed camping only, Big Bayhorse Lake has a Forest Service maintained 11-site campground with vault-toilets, picnic tables, and fire rings. Although boating on the Bayhorse Lakes is restricted to non-motorized use only, there is a boat ramp and boat/fishing docks on both lakes for launching canoes, float tubes, and other non-motorized watercraft.

The earliest recorded stocking event for Big Bayhorse Lake was in 1922, and for Little Bayhorse Lake was in 1957. However, due to the proximity of the lakes to the historic mining town of Bayhorse (established in 1877), it is likely they would have been stocked by local miners prior to those recorded events. Prior to 1962 (when the road was constructed), access to the Bayhorse Lakes was limited to foot and horse traffic only. After the road was constructed, angler use at the Bayhorse Lakes likely increased considerably. According to recorded stocking events, Brook Trout *Salvelinus fontinalis* had been stocked in Big Bayhorse Lake from 1937 to 1955, but stocking since then at both Bayhorse Lakes has been almost exclusively Rainbow Trout *O. mykiss*, with occasional introductions of Cutthroat Trout as well (IDFG – historical stocking database). Currently, we request for Big Bayhorse Lake to be stocked with 4,000 catchable Rainbow Trout annually, and for Little Bayhorse Lake to be stocked with 2,000 catchable Rainbow Trout annually. In addition to annual stocking of catchable Rainbow Trout, Big and Little Bayhorse Lakes were each stocked with just over 12,000 Westslope Cutthroat Trout fingerlings in 2015 and 8,500 Westslope Cutthroat Trout fingerlings in 2018.

One sinking and one floating standard experimental gillnet were set at each lake, overnight on June 30, 2019. We also angled for one hour at Big Bayhorse Lake. We did not angle at Little Bayhorse Lake due to time constraints.

Buster Lake

Buster Lake (WGS84 datum: 44.43980º N, -114.415529º W) is located at the upper end of Garden Creek, approximately 20 km from the town of Challis, in the Salmon-Challis National Forest (SCNF). It is a natural lake that has a surface area of 3.1 ha and sits at 2,610 m in elevation. The lake is accessible by full size vehicle, and there are several nice primitive camping areas present. In 1908, the Forest Service issued William Buster a special use permit to turn Buster Lake into a water storage reservoir, by completing a tunnel through the rock below and installing a gate to control flow. A new owner took over the permit in 1931 and signed into an agreement with the Forest Service to share maintenance responsibility. From then until around 1979, the Forest service maintained majority ownership of the water in the lake. In 1961, Buster Lake was last estimated to hold approximately 139 acre feet of water when full (Buster Lake Dam Meeting transcripts, 1982). The Forest Service gave their share of the water to the City of Challis in 1979.

According to our stocking records, IDFG began stocking the lake in 1937 with 2,000 Brook Trout from Ashton Hatchery. It was stocked once with Rainbow Trout in 1938, then was stocked solely with Brook Trout several times until 1998, and was last stocked in 2001 with Rainbow Trout. In 2002, it was determined that Brook Trout were outcompeting Rainbow Trout, and stocking was halted.

We set two pairs of standard lowland lake gillnets (one sinking and one floating, per pair) overnight in Buster Lake on the evening of July 8, 2019. We also angled for 3.9 hours at Buster Lake to assess catch rates.

Yellow Jacket Lake #2

Yellow Jacket Lake (Yellow Jacket Lake #2, WGS84 datum: 45.06774º N, -114.55219º W) is a 2.7-ha cirque lake located in the SCNF approximately 53 km west of the town of Salmon, Idaho. At 2,422 m in elevation, the lake and its seven-site campground serve as a popular trailhead staging area adjacent to the Frank Church River of No Return Wilderness and the Bighorn Crags. Rainbow Trout were stocked annually in the lake as catchables from 1968 until 1996, with two additional stockings of Rainbow Trout fry added in 1999 and 2003. Introductory stockings of Cutthroat Trout fry were made in 1996 and 1998 with 500 and 620 fry, respectively. Beginning in 2010, IDFG increased stocking efforts at Yellow Jacket Lake to an average of 6,300 Westslope Cutthroat Trout fry annually. A 1988 creel survey estimated 1,990 hours of angler effort with a catch rate of 0.54 fish/h, and 54% return-to-creel for the approximately 1,997 Rainbow Trout stocked that year (Lukens and Davis, 1989). Yellow Jacket Lake was last surveyed with gill nets in 2013.

One pair of standard lowland lake gillnets were set overnight in Yellow Jacket Lake on the evening of July 29, 2019. We accrued 3 hours of angling effort to assess catch rates.

Iron Lake #2

Iron Lake (Iron Lake #2) (GS datum: 44.90680ºN, -114.19459ºW) is a cirque lake located in south-central Lemhi County at the southern end of SCNF Road #20, commonly called the Salmon River Mountain or Salmon Ridge Road, about 38 km southwest of the town of Salmon. The lake is situated at 2,685 m in elevation with a surface area of 6.6 ha. The lake is a popular fishery in summer months due to its eight-site campground and relatively easy access. Iron Lake has been stocked annually since 1968 (with the exception of 1984) with Rainbow Trout and Westslope Cutthroat Trout.

Two pairs of standard lowland lake gillnets were set overnight in Iron Lake on the evening of September 25, 2019. We also angled for six hours at Iron Lake to assess catch rates.

Wallace Lake

Wallace Lake (WGS84 datum: 45.24625º N, 114.00730º W) is a small, 3.0-ha lake located approximately 32 km (road distance) from the town of Salmon (10 km straight distance). The lake sits at an elevation of approximately 2,470 meters, and has a maximum depth of approximately 10 meters. This lake has been managed as a put-and-take Rainbow Trout fishery since 1968, and has also received periodic stocking of Cutthroat Trout fry and fingerlings since the mid-1990s. In 2014, we assessed return-to-creel rates on approximately 2,150 stocked catchable Rainbow Trout in the lake. Harvest and total use were 15.4% and 22.3%, respectively, (Messner et al. 2016), but fish condition (mean relative weight) was poor, presumably due to competition with the expanding Redside Shiner population in the lake. In June 2015, we first stocked 1,795 catchable-size (200 to 370 mm TL) tiger trout in an attempt to reduce abundance of Redside Shiners and increase available forage for stocked catchable Rainbow Trout. Catchable-sized tiger trout were stocked again annually from 2016 to 2019.

RESULTS AND DISCUSSION

Big Bayhorse Lake

We caught 33 Rainbow Trout in 32.6 hours of gillnetting on June 30, 2019 in Big Bayhorse Lake (CPUE = 1.01 fish/h) (Table 3, Figure 2). Mean TL (± SE) of Rainbow Trout was 295 (± 4.5) mm, and ranged from 212 to 336 mm (Table 4, Figure 2). The mean relative weight was 91 (range = 72 to 149; Table 4, Figure 3). One Westslope Cutthroat Trout (TL = 330 mm) was caught while fishing during the sampling effort (Table 4). Angling CPUE was 1.3 fish/h with 5 fish caught (4 RBT, 1 WCT) during 3.9 hours of effort (Table 3).

We did not catch any Westslope Cutthroat Trout via gillnetting and only one while angling in Big Bayhorse Lake in 2019, suggesting that fry stocking in 2015 was mostly unsuccessful. Cutthroat Trout stocked in 2018 were likely not yet large enough to recruit to our gill net (typically > 200 mm TL). The goal of Westslope Cutthroat Trout introductions in 2015 was to provide more diverse angling opportunity and establish a self-sustaining population to supplement angler harvest more than is currently being provided by catchable Rainbow Trout stocking. There also does not appear to be sufficient Westslope Cutthroat Trout spawning habitat. The inlet is very marshy with high amounts of silt and cattails. Cutthroat Trout, in general, have been found to be extremely vulnerable to angling (MacPhee 1966; Schill et al. 1986). This vulnerability may also be cause for the disproportionate catch of Westslope Cutthroat Trout to Rainbow Trout in our angling and gillnet surveys because exploitation may be higher for Westslope Cutthroat Trout than Rainbow Trout at Big Bayhorse Lake. Although, Rainbow Trout size and body condition (relative weight) currently provide quality angling opportunity in Big Bayhorse Lake, diversifying the fish composition and improving catch rates would provide further benefit to anglers, and thereby increase the overall quality of the fishery. To produce a mixed Rainbow Trout/Westslope Cutthroat Trout fishery we have several strategies available involving alternative stocking regimes. We could change Rainbow Trout stocking to fry instead of catchables, stop stocking Rainbow Trout for several years, decrease Rainbow Trout catchable stocking rates or increase Westslope Cutthroat stocking rates until the Westslope Cutthroat Trout fishery is developed. Future monitoring in 2022 should allow us to definitively determine whether the 2018 Westslope Cutthroat Trout fry introductions were successful, and help us direct future management of the fishery by augmenting stocking regimes to accomplish the goal of having a mixed species fishery. If our results in 2022 are similar to 2019, we will need to augment the stocking of Rainbow Trout or Westslope Cutthroat Trout to develop a more evenly mixed fishery.

Little Bayhorse Lake

Nine Rainbow Trout and 17 Westslope Cutthroat Trout were caught in 32 hours of gillnetting at Little Bayhorse Lake (CPUE = 0.81 fish/h, Table 3; Figure 4). Mean TL (± SE) of Rainbow Trout was 303 mm (± 4.4), and ranged from 282 to 330 mm (Table 4, Figure 4). Mean relative weight of Rainbow Trout was 87 (range = 78-100). Mean TL (± SE) of Westslope Cutthroat Trout was 255 mm (± 10.5) and ranged from 105 to 307 mm (Table 4, Figure 4). Mean relative weight of Westslope Cutthroat Trout was 81 (range = 63-91; Table 4, Figure 5). An angling survey was not performed at Little Bayhorse Lake due to time constraints; however, several fisherman were observed catching fish while we were surveying.

Our results indicate that the 2015 introduction of Westslope Cutthroat Trout into Little Bayhorse Lake has been successful in supplementing and creating a more diverse angling experience, unlike at Big Bayhorse Lake where only one Westslope Cutthroat was sampled in the gillnet survey. This may be due to the lower stocking rate of Rainbow Trout at Little Bayhorse Lake. The stocking rate at Big and Little Bayhorse lakes are 533 RBT/ha and 307 RBT/ha, respectively. While, both lakes were stocked equally with Westslope Cutthroat Trout in 2015, Little Bayhorse had a 15% higher WCT stocking density (fish/ha) when considering the lower surface area. At the same time, it received half the number of catchable Rainbow Trout, which may have improved survival of fingerling WCT. It is unlikely that the Westslope Cutthroat Trout population in Little Bayhorse Lake will be self-sustaining due to lack of suitable spawning area but survival from fingerling to adults appears to be adequate to diversify the fishery. We recommend to continue stocking Westslope Cutthroat trout into Little Bayhorse Lake annually at 1,700 fingerings/ha for a total of approximately 12,000 fingerlings year.

Buster Lake

Sixty-eight Brook Trout were sampled at Buster Lake during 56.4 hours of gillnetting (CPUE = 1.2 fish/h, Table 3). Average TL of Brook Trout sampled was 285 mm (± 4.7) and ranged from 210-364 mm; Table 4, Figure 6). Average relative weight was 96 (range = 60-149; Table 4; Figure 7).

Our results indicate that the Brook Trout population in Buster Lake is self-sustaining and not stunted. Buster Lake likely possesses the best size structure of lakes containing Brook Trout in Region 7. No fish were angled at Buster Lake during 3 hours of effort. No changes to management of Buster Lake are recommended at this time.

Yellow Jacket Lake

Twenty-two Westslope Cutthroat Trout and 8 Rainbow Trout were caught during 27.4 hours of gillnetting (CPUE = 1.06 fish/h). Mean TL (± SE) of sampled Westslope Cutthroat Trout was 227 mm (± 9.9) and ranged from 160 to 305 mm (Table 4, Figure 8). Mean TL of sampled Rainbow Trout was 221 mm (± 20) and ranged from 165 to 350 mm; Table 4, Figure 8). Average relative weight of Westslope Cutthroat Trout was 83 (range = 63-102; Table 4, Figure 9). Average relative weight of Rainbow Trout was 82 (range = 53-104; Table 4, Figure 9). Angling CPUE over 3 angler hours was 1.3 fish/h (Table 3).

Our results indicate that stocking of Westslope Cutthroat Trout fingerlings is successful at Yellow Jacket Lake and the lake continues to provide a quality fishing opportunity. During our survey of Yellow Jacket Lake we observed unknown species of trout fry at the outlet of the lake. There appears to be some quality spawning habitat, and this area is likely the source of Rainbow Trout natural reproduction since Rainbow Trout have not been stocked since 2003. We were not able to confirm if natural reproduction is occurring in the Westslope Cutthroat Trout population since it has been stocked almost yearly since 2010. Backpack electrofishing of the inlet during the next survey in 2022 would be sufficient to determine if both RBT and WCT are successfully in reproducing in Yellow Jacket Lake. We recommend no changes to management of Yellow Jacket Lake.

Iron Lake

Twenty-three Rainbow Trout and 13 Westslope Cutthroat Trout were caught during 61.0 hours of gillnetting (CPUE = 0.59 fish/h, Table 3). Mean TL (± SE) of Westslope Cutthroat Trout sampled was 267 mm (± 13.1) and ranged from 126 to 307 mm. (Table 4, Figure 10). Mean TL of Rainbow Trout sampled was 271.2 mm (SE = 3.7; range = 206-296 mm; Table 4, Figure 10). Average relative weight of Westslope Cutthroat Trout was 74 (range = 69-95; Table 4; Figure 11). Average relative weight of Rainbow Trout was 78 (range = 66-95; Table 4, Figure 11). Angling catch rates at Iron Lake were excellent at 3.3 fish/h (Table 3).

Our survey results indicate that Iron Lake is continuing to provide a diverse fishing opportunity in the Salmon Region. Additionally, it appears that stocked Westslope Cutthroat fingerlings are able to overwinter and survive to adult stage. The current stocking regimen appears to be producing a quality fishing opportunity. No changes are recommended for Iron Lake.

Wallace Lake

We caught 191 Redside Shiner in June and 141 Redside Shiner in July in a total of 570 and 563 minutes of minnow trapping effort, respectively. Overall mean catch per unit-effort (CPUE) was 0.34 fish/min in June and 0.25 fish/min in July. From 2018 to 2019, overall mean CPUE showed a significant decline (F = 8.18, df = 1, P = 0.01), and overall mean CPUE has decreased each year since monitoring began in 2014. From 2018 to 2019, among months, mean CPUE showed a significant decrease in July (Tukey's; P < 0.02), but no significant difference was detected in June.

Reside Shiner CPUE indicates a significant decline in abundance has occurred since the introduction of tiger trout into Wallace Lake in 2015. Predation, competition for forage, and behavioral changes are all likely contributing to the decline in shiner relative abundance. Redside Shiners < 80 mm TL are likely ideal prey for tiger trout in Wallace Lake (Winters 2014), and length-frequency data from June trapping shows that the relative proportion of shiners < 80 mm TL has decreased since 2015 (Table 5; Figure 12; Figure 13). Winters (2014) showed that tiger trout often will not switch to piscivory until > 340 mm TL, and tiger trout stocked in Wallace Lake in 2017 had a mean TL of 273 mm (Messner et al. 2018). If a large proportion of tiger trout in Wallace Lake have not switched to piscivory then they are likely competing with Redside Shiners, Rainbow Trout, and other tiger trout for zooplankton forage. This competition could result in lower relative weights in tiger trout and lower relative abundance of shiners. Anecdotally, we have observed low relative weights of tiger trout via angling since the beginning of stocking. Prior to the introduction of tiger trout, shiners were visible throughout the lake's littoral areas, and after introduction, shiners were observed in higher densities near covered habitat. Behavioral changes could partially explain the decline in relative Redside Shiner abundance since 2015, but documenting behavioral changes would be challenging. We recommend continuing to monitor Reside Shiner relative abundance, size structure, and condition.

MANAGEMENT RECOMMENDATIONS

1. Pending results of 2022 sampling at Big Bayhorse Lake, determine if continuing to stock Westslope Cutthroat Trout is appropriate or if stocking rates need to be augmented for Rainbow Trout or Westslope Cutthroat Trout.

2. Continue to stock Westslope Cutthroat Trout fingerlings in Little Bayhorse Lake annually at a density of 1,700/ha to provide diverse angling opportunity.

3. Identify if Rainbow Trout, Westslope Cutthroat Trout or both species are naturally reproducing in Yellow Jacket Lake during scheduled survey in 2022.

4. Continue to annually monitor Redside Shiner relative abundance, condition, and size structure in Wallace Lake. Re-evaluate and adjust predator stocking as necessary.

Table 3. Catch-per-unit-effort (CPUE [fish/h]) for angling and gillnetting surveys at Big Bayhorse, Little Bayhorse, Buster, Yellow Jacket, and Iron lakes in 2019.

Lake	Effort type	Sample size	Effort (h)	CPUE (fish/h)
Big Bayhorse Lake	gillnet	33	32.6	1.0
	angling	5	3.9	1.3
Little Bayhorse Lake	gillnet	26	32.0	0.8
Buster Lake	gillnet	15	42.0	0.4
	angling	0	3.0	0.0
Yellow Jacket Lake	gillnet	30	27.4	1.1
	angling	4	3.0	1.3
Iron Lake	gillnet	36	61.0	0.6
	angling	20	6	3.3

Table 4. Species, number of fish captured, mean total length and range in mm, and mean relative weight (W_r) and relative weight range for fish sampled in Big Bayhorse Lake, Little Bayhorse Lake, Buster Lake, Yellow Jacket Lake, and Iron Lake in 2019. RBT=Rainbow Trout, WCT=Westslope Cutthroat Trout, BKT = Brook Trout.

			Total length (mm)		Relative weight (W_r)	
Lake	Species	Sample size	Mean	Range	Mean	Range
Big Bayhorse Lake	RBT	33	295	212-336	93	73-150
Little Bayhorse Lake	RBT	9	303	282-330	87	79-100
	WCT	17	255	105-307	81	63-91
Buster Lake	BKT	68	284	210-364	96	60-149
Yellow Jacket Lake	RBT	8	221	165-350	82	53-104
	WCT	22	227	160-305	83	63-102
Iron Lake	RBT	23	271	206-296	78	66-95
	WCT	13	267	126-307	74	69-95

Table 5. Summary statistics from Wallace Lake Redside Shiner sampling, 2013-2019, including Redside Shiner sub-sample size (n), relative abundance (CPUE), total length statistics (mm), and condition factor (K).

			Total length (mm)				Condition factor (K)		
Date	Total # caught	CPUE (fish/min)	*n*	Min	Max	Mean (SE)	Min	Max	Mean (SE)
August 2013	101	1.12	101	57	141	86 (1.21)	0.50	1.08	0.77 (0.01)
June 2014	647	2.70	480	73	156	93 (0.48)	0.41	1.59	0.88 (0.01)
August 2014	178	0.74	178	41	140	83 (1.10)	0.35	1.46	0.82 (0.01)
September 2014	1,818	3.30	457	45	149	89 (0.75)	0.44	1.32	0.86 (0.00)
June 2015	1,670	3.01	455	57	147	95 (0.75)	0.40	1.16	0.82 (0.00)
July 2015	3,107	5.74	450	53	156	94 (0.84)	0.45	2.10	0.82 (0.01)
September 2015	666	1.22	371	42	156	91 (1.09)	0.26	1.47	0.82 (0.01)
June 2016	1,568	2.67	450	64	149	92 (0.65)	0.39	1.23	0.82 (0.00)
July 2016	1,739	3.27	450	55	159	93 (0.71)	0.57	1.20	0.84 (0.00)
September 2016	327	0.57	148	49	129	92 (0.87)	0.53	1.31	0.92 (0.01)
June 2017	469	0.89	217	64	138	97 (0.77)	0.63	1.18	0.91 (0.00)
July 2017	1,693	3.03	450	64	145	94 (0.53)	0.42	1.28	0.85 (0.00)
September 2017	291	0.53	153	25	145	94 (1.70)	0.56	1.20	0.88 (0.01)
June 2018	345	0.58	273	67	139	101 (0.67)	0.58	1.04	0.82 (0.01)
July 2018	575	1.09	326	64	142	100 (0.72)	0.54	1.05	0.83 (0.07)
September 2018	328	0.64	215	48	142	103 (1.08)	0.52	1.14	0.82 (0.01)
June 2019	192	0.34	190	65	157	102 (0.81)	0.38	1.29	0.79 (0.01)
July 2019	141	0.25	141	51	141	94 (1.31)	0.53	1.38	0.83 (0.01)

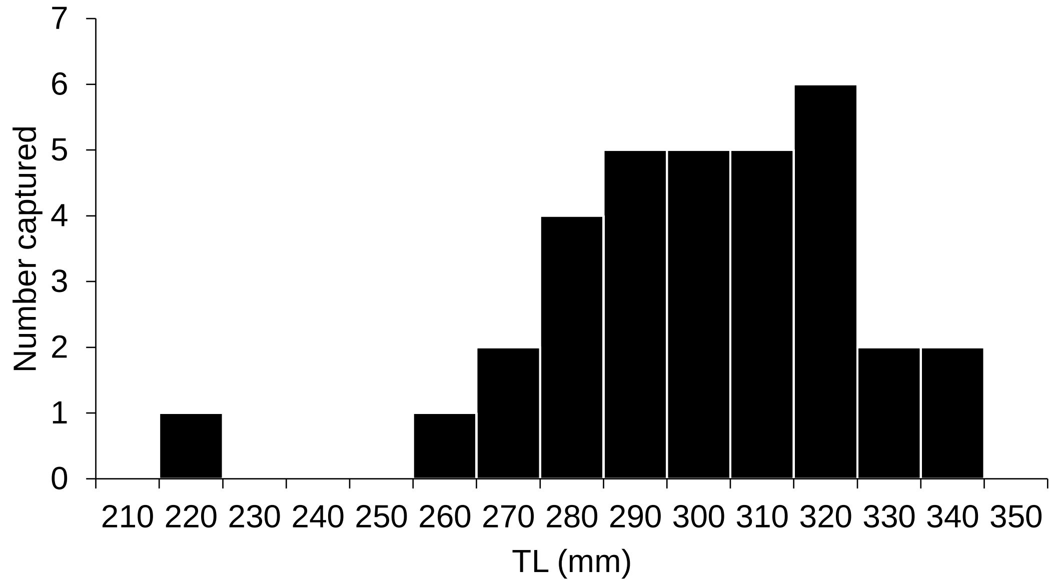

Figure 2. Length-frequency histogram of Rainbow Trout captured during gill netting at Big Bayhorse Lake in 2019.

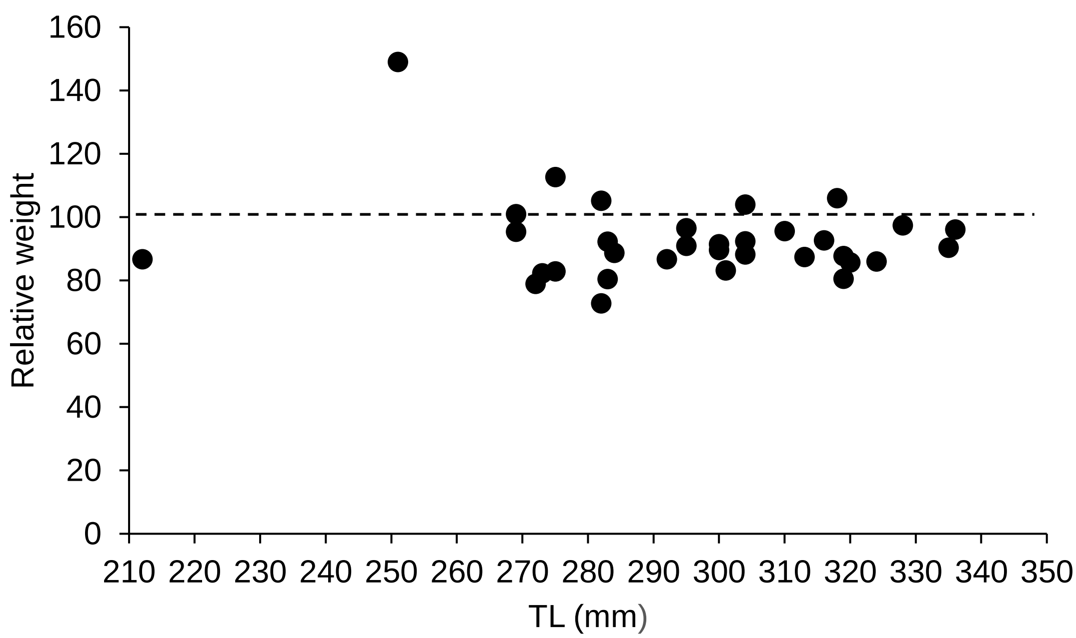

Figure 3. Total length (TL) and relative weight (W_r) of Rainbow Trout captured during gillnetting at Big Bayhorse Lake in 2019.

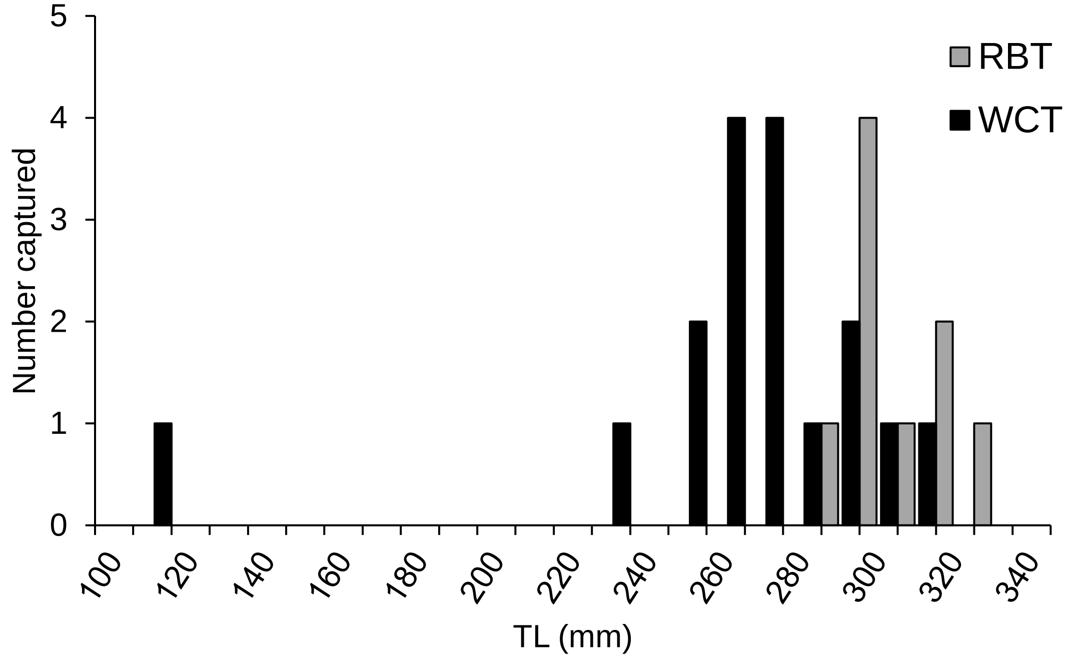

Figure 4. Length-frequency histogram of Rainbow Trout (RBT) and Westslope Cutthroat Trout (WCT) sampled at Little Bayhorse Lake in 2019.

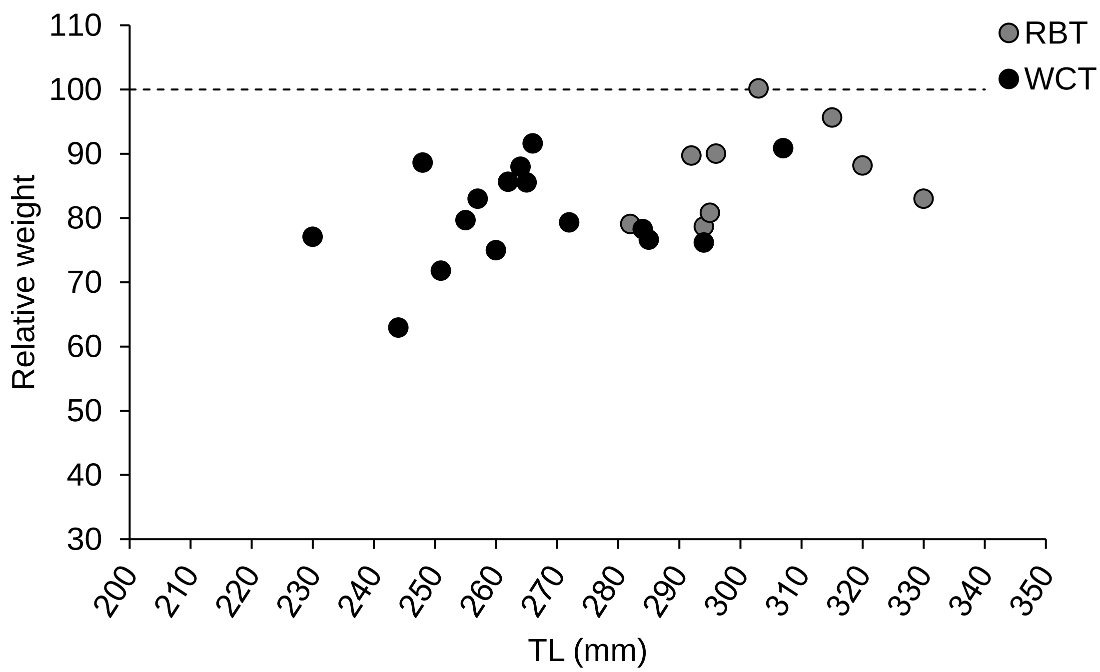

Figure 5. Total length (TL) and relative weight (W_r) of Rainbow Trout (RBT) and Westslope Cutthroat Trout (WCT) sampled at Little Bayhorse Lake in 2019.

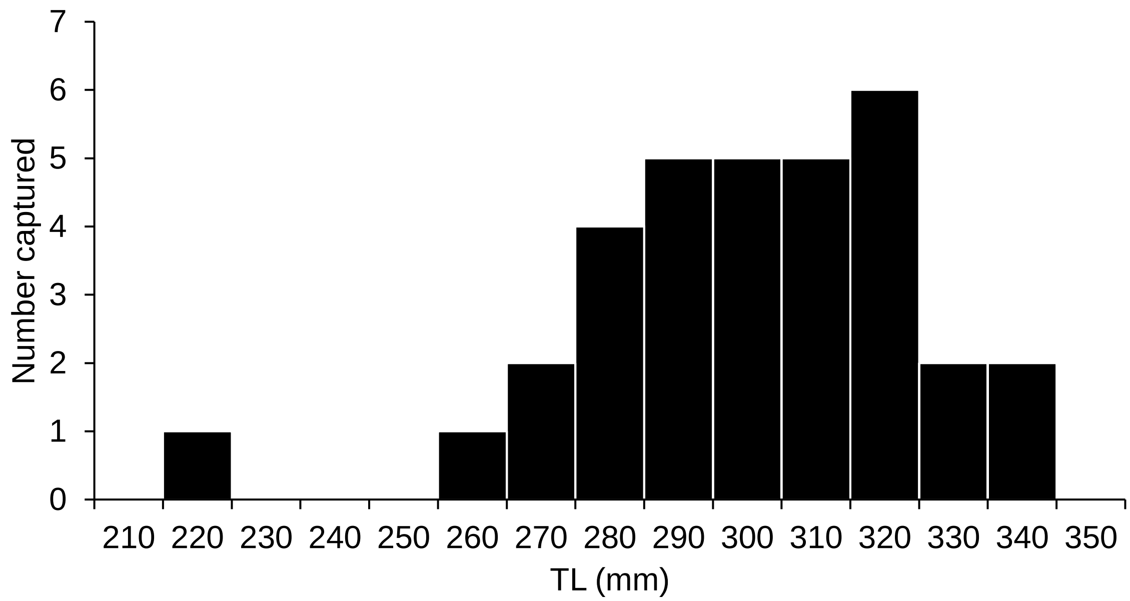

Figure 6. Length-frequency histogram of Brook Trout sampled at Buster Lake in 2019.

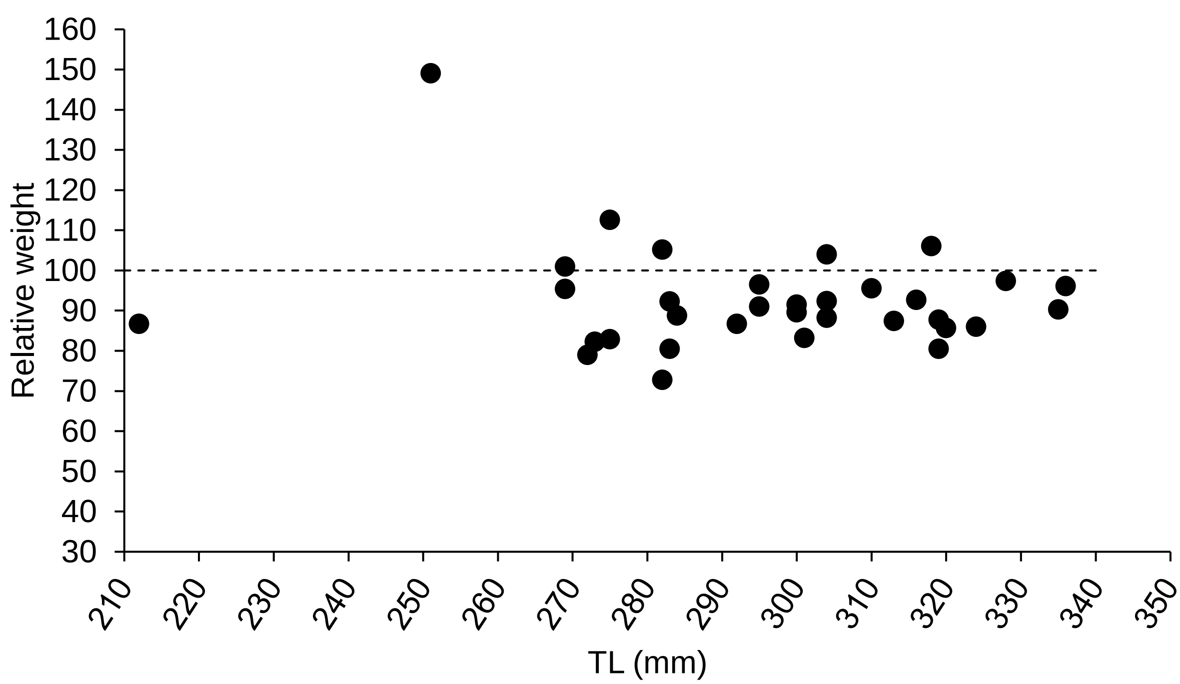

Figure 7. Total length (TL) and relative weight (W_r) of Brook Trout sampled at Buster Lake in 2019.

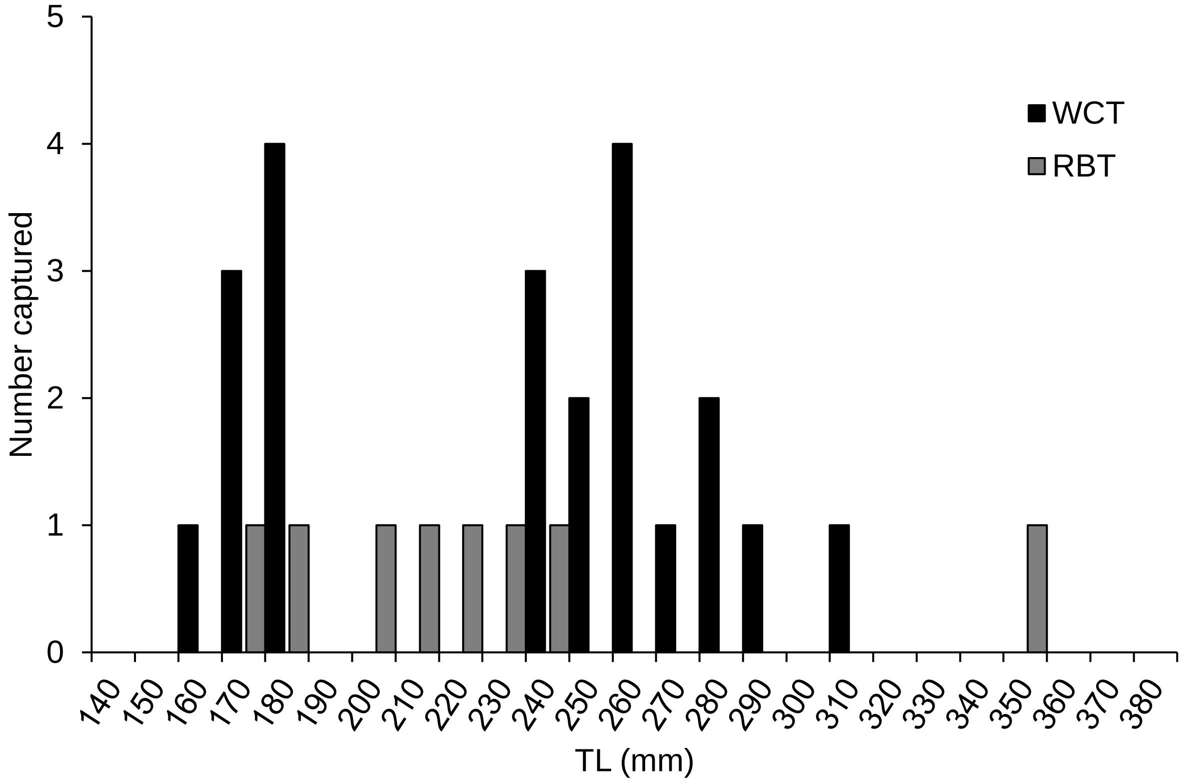

Figure 8. Length-frequency histogram of Rainbow Trout (RBT) and Westslope Cutthroat Trout (WCT) sampled at Yellow Jacket Lake in 2019.

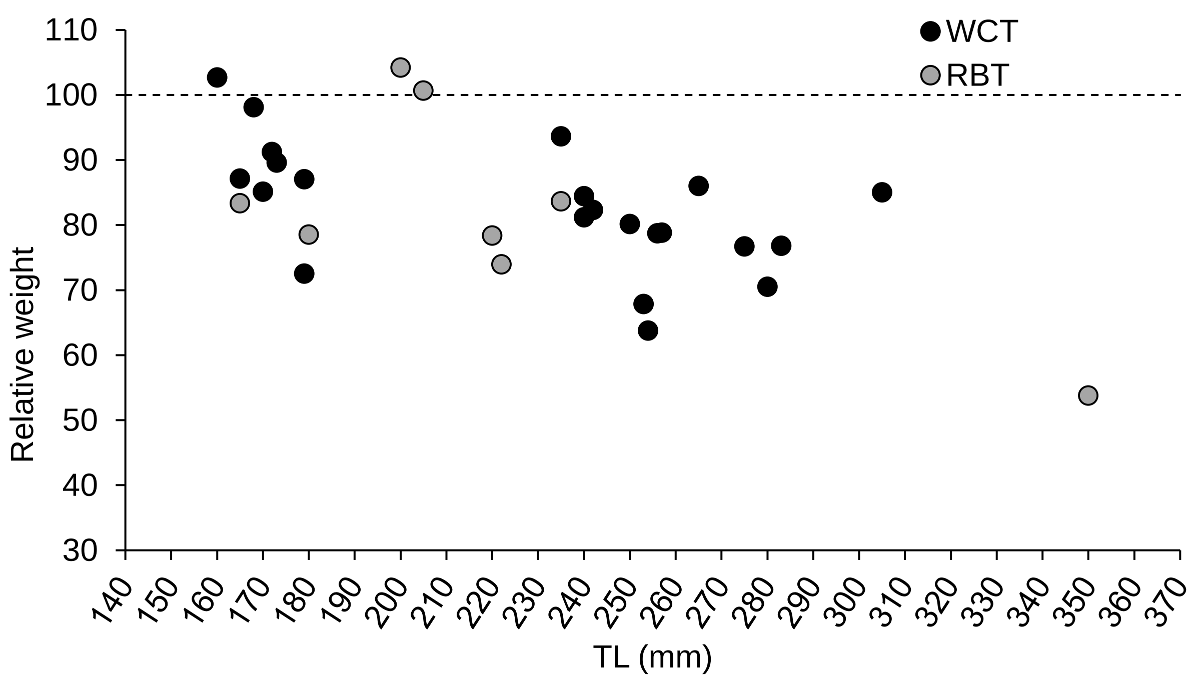

Figure 9. Total Length (TL) and Relative Weight (W_r) of Rainbow Trout (RBT) and Westslope Cutthroat Trout (WCT) sampled at Yellow Jacket Lake in 2019.

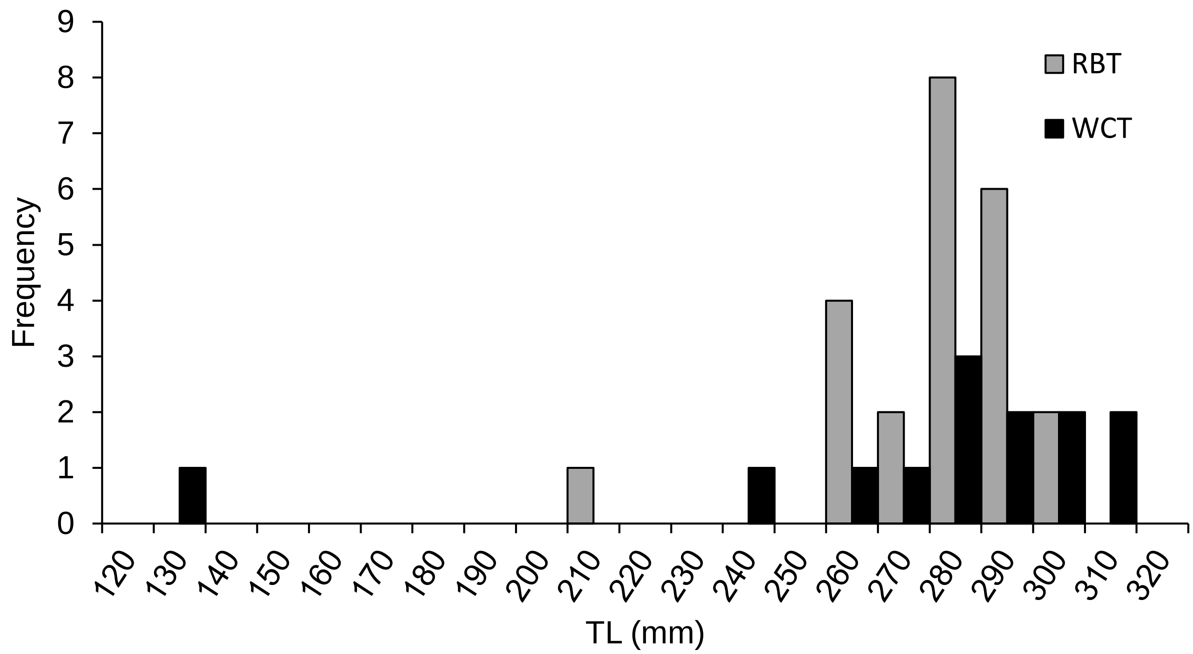

Figure 10. Length-frequency histogram of Rainbow Trout (RBT) and Westslope Cutthroat Trout (WCT) sampled at Iron Lake in 2019.

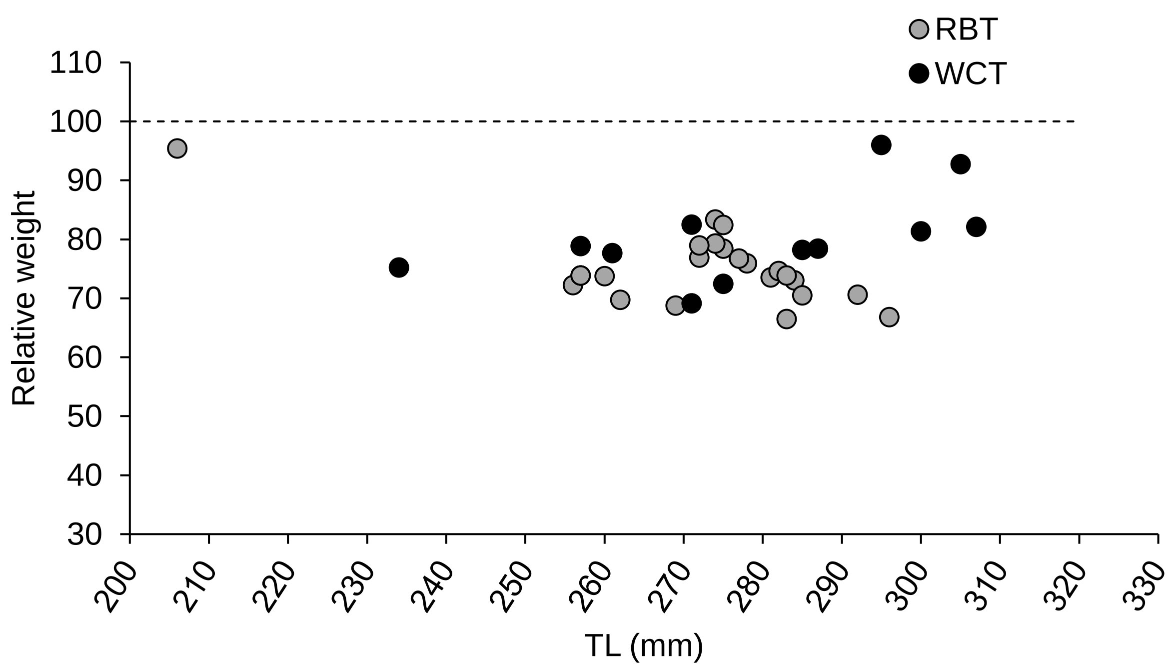

Figure 11. Relative weights (W_r) of Rainbow Trout (RBT) and Westslope Cutthroat Trout (WCT) sampled at Iron Lake in 2019. Dashed line represents (W_r) of 100.

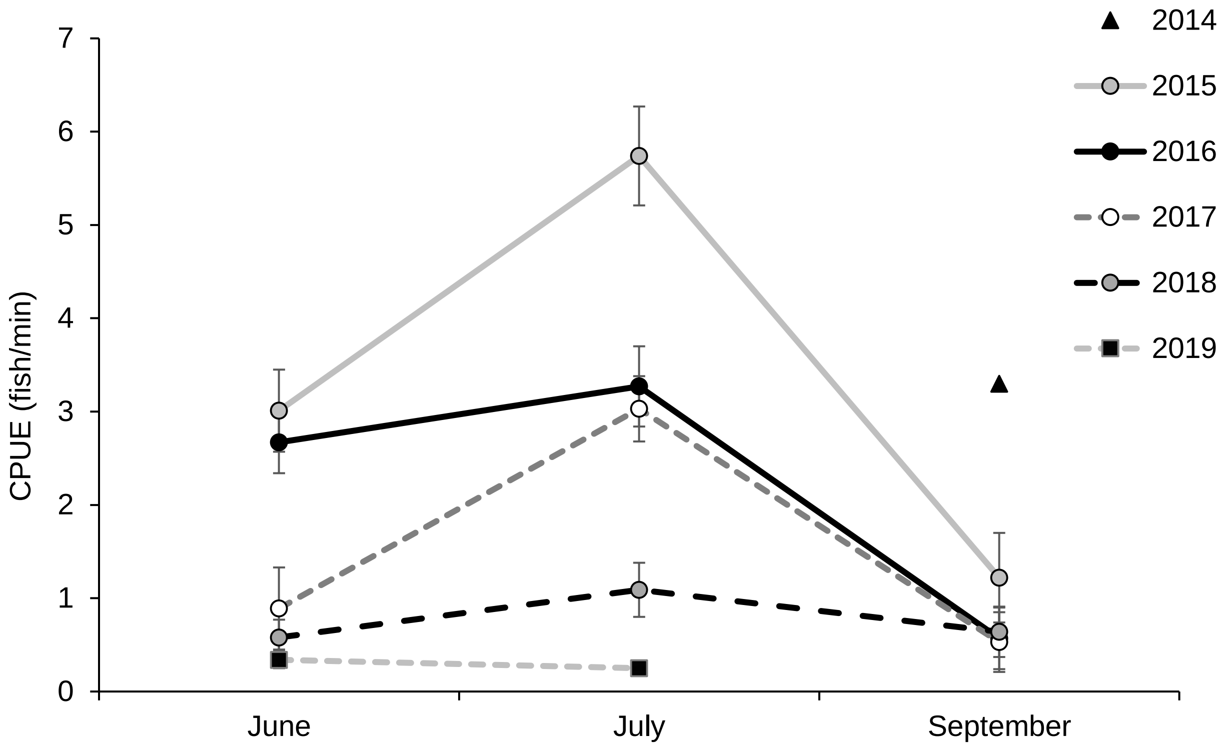

Figure 12. Catch-per-unit-effort (fish/min ± SE) of Redside Shiners captured during minnow trapping in Wallace Lake in June, July, and September 2014-2019.

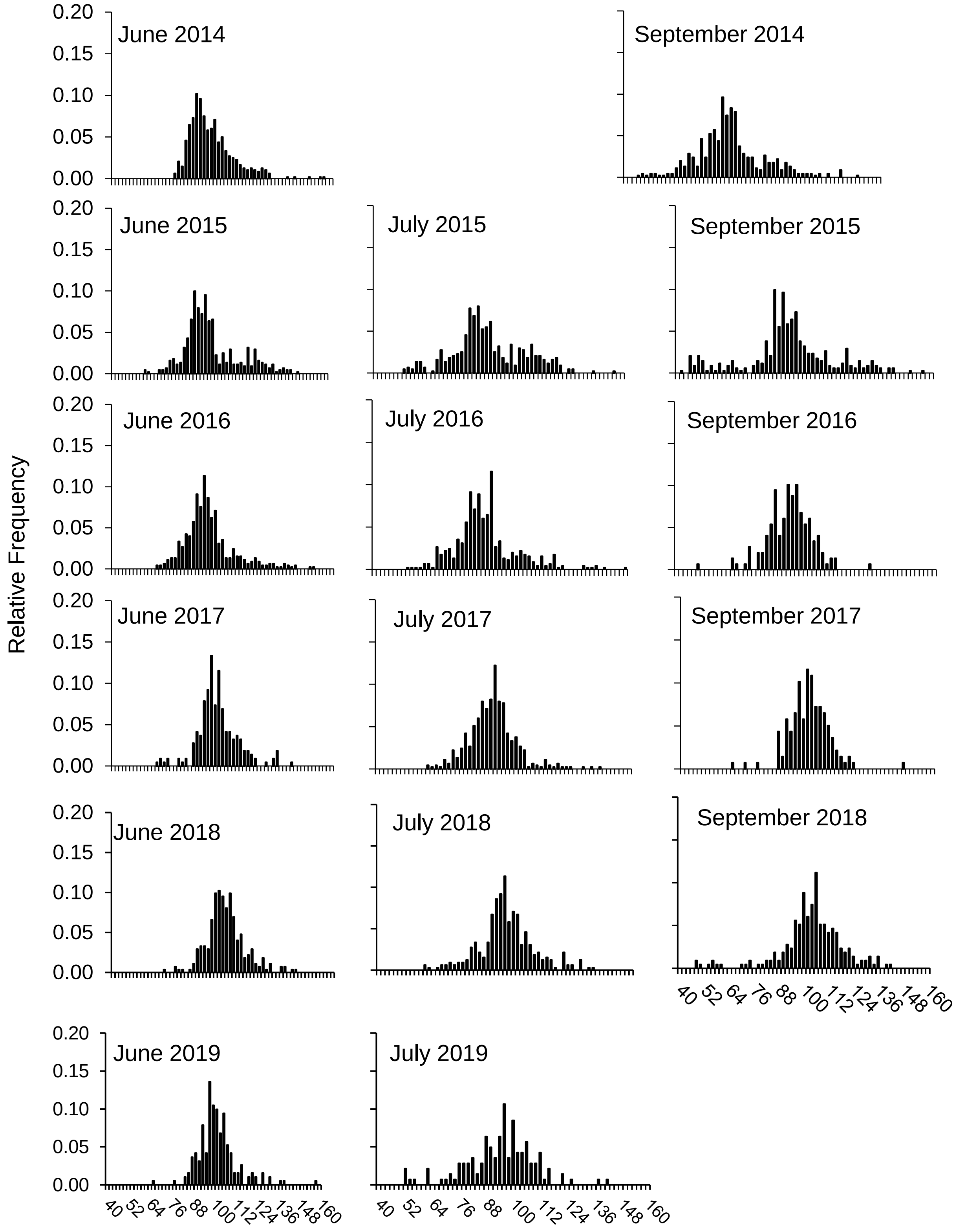

Figure 13. Size structure of Redside Shiner in Wallace Lake during sampling efforts from June, 2014 to July 2019. June 2014 is the only sampling date where four minnow traps were used, versus the nine clusters of three traps used for all other periods.

LOWLAND LAKES AND RESERVOIRS: STANLEY LAKE

ABSTRACT

We implemented an acoustic telemetry study to gain understanding of the seasonal movement of Lake Trout *Salvelinus namaycush* which may improve efficiency of efforts to extirpate fertile Lake Trout from this lake and the Stanley Basin. Commercial removal is slated to start in 2020 as part of the implementation of the Stanley Lake Management Plan drafted in 2018. We implanted acoustic transmitters equipped with depth and temperature sensors in 40 Lake Trout ranging in TL from 381 to 862 mm. Lake Trout were tracked weekly from June 6 to November 1, 2019 with a period of more intense tracking during October, coinciding with suspected spawning period. Results suggest that Lake Trout use the majority of Stanley Lake throughout the season, concentrating at a depth of 10-20 m with Lake Trout at various depths observed during each tracking session. One congregation was formed near the inlet around October 23rd but disbursed by October 26th. We suggest that commercial gillnetters focus at depths of 10-20 m during removal operations during the summer and fall. A creel survey was also implemented from June to October 2019. We estimated 5,853 h of angling effort, with the highest amount of effort estimated in July at 2,837 angler hours.

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INTRODUCTION

The earliest reference of Stanley Lake's fishery status and potential was published in a 1935 document written by a temporary biologist working for the Challis National Forest (Rodeheffer 1935). At that time, despite prior attempts to create a sport fishery by planting Brook Trout *Salvelinus fontinalis*, kokanee *Oncorhynchus nerka*, and Rainbow Trout *O. mykiss*, Stanley Lake was primarily composed of native nongame fish (suckers *Catastomus spp*., Northern Pikeminnow *Ptychocheilus oregonensis*, and likely Redside Shiner *Richardsonius balteatus*). Between 1940 and 1951, IDFG stocked approximately 6,000 catchable Rainbow Trout, 18,000 Cutthroat Trout *O. clarkii* fry, and 400,000 Sockeye Salmon *O. nerka* fry in Stanley Lake to enhance angling opportunity (IDFG stocking database). However, these attempts at establishing sport fish were apparently unsuccessful. In 1954, Stanley Lake only received an estimated 50 angler days of effort annually (IDFG 1954). By comparison, nearby Redfish and Alturas Lakes received an estimated 3,000 angler days annually at that time.

In September 1954, IDFG launched a major effort to improve the sport fishery at Stanley Lake, which included chemical treatment (toxaphene) and construction of an upstream fish migration barrier at the lake outlet to prevent re-colonization of non-game fish (IDFG 1954). In 1956, IDFG resumed stocking of hatchery catchable Rainbow Trout, which have been stocked in Stanley Lake annually ever since. After 2000, all Rainbow Trout stocked into Stanley Lake have been sterile (triploid). The only other fish stocked in Stanley Lake since 1956 were kokanee fingerlings (1988-1991), Sockeye Salmon fingerlings (1981-1984), and Lake Trout *S. namaycush* fingerlings (1975).

Currently, the upper Salmon River basin is a very popular destination for tourists during summer months. Many lakes in the basin provide angling opportunity, but Stanley Lake now sees the most angler use of all the lakes in the upper Salmon River basin. In 2011, estimated angler use at Stanley Lake was 12,848 hours, compared to 2,816 hours at Redfish Lake and 3,348 hours at Alturas Lake in 2010 (IDFG unpublished data). During a 2003 economic assessment, Stanley Lake was ranked 4th in Custer County for total angler expenditures. The lake was estimated to have generated over $1.9 million in total expenditures from anglers traveling to fish Stanley Lake (Grunder et al. 2008).

In 2017 and 2018 IDFG convened a group of stakeholders and to develop the Stanley Lake Management Plan. The presence of Lake Trout in Stanley Lake has been identified as a potential limiting factor to Sockeye Salmon recovery efforts in the Sawtooth Valley (NOAA 2015). The primary concern with Lake Trout inhabiting Stanley Lake is the potential for migration, colonization, and establishment of Lake Trout populations in the neighboring Sawtooth Valley lakes (Redfish, Pettit, Alturas, and Yellowbelly). To address this risk, IDFG agreed to replace the fertile Lake Trout population with a sterile population to mitigate the risk of colonization to the adjacent lakes. As part of the Stanley Lake Management Plan, we will implement the commercial removal of fertile Lake Trout in 2020. We will contract with commercial gillnetters to remove Lake Trout at Stanley Lake. In an effort to maintain a Lake Trout fishery we will work to transplant sterile (triploid) Lake Trout from Bear Lake, ID as well as stock catchable size triploid Lake Trout at Stanley Lake that will be raised at the Grace Hatchery.

OBJECTIVES

1. Learn general movements of Lake Trout to aid in removal efforts and increase future sampling efficiency.

2. Evaluate angler use and movement of Lake Trout through the use of spaghetti and PIT tags.

3. Conduct a creel survey to evaluate angler use, catch rates, and harvest to compare pre- and post-Lake Trout removal angler use and catch rates.

STUDY SITES AND METHODS

Stanley Lake (WGS84 datum: 44.24371º N, 115.05653º W) is located in the Stanley Basin, near Stanley, Idaho. Stanley Lake is 71.3 ha in surface area and sits at 1,990 m in elevation. IDFG first stocked the lake in the 1940's, and has been stocking hatchery catchable Rainbow Trout since 1956 (IDFG stocking website). Recently we have stocked ~9,500 Catchable Rainbow Trout in 2016, and ~8,500 in 2017, ~19,000 in 2018, and ~6,500 in 2019. The Sawtooth Basin is a popular destination during summer months, so the lake is managed as a put-and-take trout fishery. In addition to stocked Rainbow Trout, there are naturally-reproducing kokanee, Brook Trout, Westslope Cutthroat Trout, Bull Trout *S. confluentus*, Lake Trout and Redside Shiner in Stanley Lake. The trout limit is six per person per day, with the exception of Brook Trout (25 per day) and Bull Trout (0 per day, catch-and-release only).

We gillnetted Stanley Lake on seven occasions from May 20 to May 30, 2019 to implement an acoustic telemetry study to inform commercial gillnetters of seasonal Lake Trout locations in Stanley Lake. Nets used were experimental graded mesh. Each net measures 100 m long and contains mesh sizes of 38-, 51-, and 64-mm stretch mesh panels measuring 33 m long each. Two identical nets were tied together to form one gang of 200 m. Nets were set in depths ranging from 10 to 25 m following a serpentine pattern.

All Lake Trout caught in the gillnets were enumerated, measured (TL; mm), and weighed (g), and sex was determined based on external examination of the urogenital region (Mohr 1982). Relative abundance (catch-per-unit-effort: CPUE) was calculated as the total number of Lake Trout caught, divided by the total number of gillnet hours. A correction factor was applied to the 2017 and 2019 data where raw CPUE was divided by 3.98 to account for differences in net area starting in 2017. We surgically implanted Lotek Acoustic Telemetry tags into 40 Lake Trout. We used two models of acoustic tags. The smaller of the two tags, model number MM-M-11-28-TP were implanted into juvenile lake trout (<550 mm TL) and measured 12 mm diameter x 53 mm long and weighed 11.5 g and had an expected battery life of 384 days. The larger tags, model number MM-M-16-33-TP were implanted in Lake Trout (>550 mm TL). These tags measured 16 mm diameter x 67 mm long and weighed 31 g and had an expected battery live of 1,033 days. Both models of tags included sensors for temperature and depth to allow us to have better resolution of Lake Trout locations. We used a LOTEK Map RT-A receiver equipped with dual hydrophones to track tagged Lake Trout.

All adult Lake Trout captured (>550 mm TL) were tagged with orange spaghetti tags (Floy™ FT4, 6 mm X 340 mm) bearing instructions for reporting catch and harvest to the Nampa Research Office Tag-You're-It program. We used the same statewide angler reporting rate estimate (58.0% in 2014) and statewide estimated tag-loss rate (2.5% for first year at large) used in the 2015 report (Messner et al. 2017) to calculate adjusted harvest and catch estimates in 2019. The estimated tagging mortality rate is a constant (0.8%, from Cassinelli 2014). Estimates for adjusted use and exploitation (u') were calculated using the formula:

$$u' = \frac{u}{\lambda(1 - Tag_l)(1 - Tag_m)}$$

Where:
u = unadjusted harvest/catch rate
λ = angler tag reporting rate
Tag_l = first year tag-loss rate
Tag_m = tagging mortality rate

Ninety percent (90%) confidence intervals were calculated for all harvest and catch estimates. For more information and details regarding these methods and associated formulas, see Meyer et al. (2010).

All captured Lake Trout were also given a PIT tag (BIOMARK APT12, 12.5 mm long x 2.03 mm diameter) for further evaluation of whether movement occurs past the Valley Creek PIT tag array, and into the upper Salmon River. PIT tags and associated fish information were entered into the PTAGIS database (ptagis.org), and alerts were set up to notify regional staff if a Lake Trout is detected crossing the Valley Creek PIT array.

We assessed angler effort, catch rates, and harvest by using a roving-roving creel survey which was conducted from June to November 2019. Creel survey interviews were scheduled in randomly chosen shifts at 4-hour intervals on 2 randomly chosen weekdays and both weekend days. We operated a 4-hour shift each day that was either termed morning, mid, or evening. A morning shift was from 08:00 to 12:00, an afternoon mid shift ran from 12:00 to 16:00 and an evening shift ran from 16:00 to 20:00. We also took a full angler count at a randomly assigned time during each shift. We assumed that the probability of an angler being interviewed was 1 during a given shift since Stanley Lake is a small system and most of the angling effort is focused from boats or a small stretch of shoreline. We collected interviews from all anglers but only included completed trips in our effort and catch calculations. Our interview results were stored and calculated in an Access database designed by IDFG Nampa Research Staff.

RESULTS AND DISCUSSION

We captured 72 Lake Trout in 220.8 total hours of gillnetting from May 20-30, 2019 (CPUE = 0.33 fish/h; adjusted CPUE = 0.08 fish/h) (Table 6; Figure 14). Lake Trout ranged in size from 190 to 878 mm TL (mean = 516 mm) (Table 6), and relative weights ranged from 67 to 118 (mean = 88), similar to 2012 and 2017 (Table 6). We captured 43 Lake Trout <550 mm TL (60%) and 29 adults >550 mm TL (40%) in 2019. Forty of the captured Lake Trout received acoustic telemetry tags as well as a spaghetti and PIT tag. These fish ranged in size from 381 to 862 mm. Four additional fish also received spaghetti tags and PIT tags, for a total of 44 adult Lake Trout captured and released in 2019 with spaghetti and PIT tags. The mean TL of Lake Trout tagged with small acoustic tags was 529 mm with a range of 381–791 mm. The mean TL of Lake Trout tagged with large acoustic tags was 673 mm with a range of 540-862 mm.

Relative abundance for Lake Trout captured in gillnets in Stanley Lake has remained low throughout the past 11 years, ranging from 0.05 to 0.27 fish/h (Table 6; Figure 14). CPUE has remained under 0.1 fish/h and varied from a high of 0.27 fish/h in 2017 to a low of 0.05 fish/h in 2012 and 2015 indicating a stable population.

Our telemetry study indicated that Lake Trout in Stanley Lake used a wide range of depths and areas. We accumulated 1,214 relocations, and were able to relocate 75% of tagged Lake Trout during each tracking event. We averaged 30 relocations per tagged fish. Average depth occupied by tagged Lake Trout over 40 tracking sessions from June 6 to November 1, 2019 was 13.3 m (range = 8.8-18.8 m; Figure 15). Typically, Lake Trout were located near the edges of the lake occupying a wide range of depths as seen on the tracking map from July 4. 2019 (Figure 16). On October 26, 2019, we observed what was likely a spawning congregation on the west side of the lake, which was disbursed by October 31 (Figures 16, 17). We did not detect any PIT tagged Lake Trout emigrating from Stanley Lake from 2019 or any other previous PIT tagging efforts.

Our creel survey results indicate that angler effort is continuing to decline from historical survey and from more recent surveys, 2011-2014. However, direct comparisons to older creel surveys should be interpreted with some caution as we used different methods. We estimated 5,853 angler hours from June-November 2019 (Figure 19). The peak month of effort was July with 2,838 hours of estimated effort (49%). October had the lowest estimated effort at 191 hours. Nearly 20% of the angling effort at Stanley Lake was from non-resident anglers. We estimated 623 Rainbow Trout, 51 kokanee, and 32 Lake Trout caught during this time period. This estimate provides and overall catch rate of 0.12 fish/h. We believe that we missed a large amount of angling effort for Lake Trout during the month of May, based on the timing of our surveys. Local anglers suggest that May is one of the best times to target Lake Trout at Stanley Lake. Additionally, during our netting in May we observed anglers targeting Lake Trout. Future creel surveys should start closer to ice-off which is typically early May. Furthermore, previous to mid-summer 2019 there was no improved boat ramp at Stanley Lake. Boats had to be launched from an unimproved beach access, which required fording a large wetland section of rough unimproved dirt road. It is possible this road had deteriorated over time and may have caused anglers to forego fishing at Stanley Lake due to its condition. Anecdotally, it appears that patrons to Stanley Lake are choosing other recreation such as paddle boarding or kayaking instead of fishing also possibly leading to a decline in angling effort. Overall, angler effort at Stanley Lake has been in decline since 2011 (Figure 19). We recommend continuing to creel Stanley Lake every 2-3 years after Lake Trout removal in order to estimate exploitation of Lake Trout and catch rates of Rainbow Trout and kokanee to determine if effort has changed in conjunction with the construction of the new boat ramp.

We had two spaghetti tags reported caught and harvested from Stanley Lake in 2019. This resulted in an adjusted exploitation estimate (±95% C.I.) of 8.1% (±9.4%) and an adjusted use estimate of 8.1% (±9.4%). The point estimate for the Lake Trout population in 2012 was 548 fish, so considering our creel estimate of 32 caught which equals 5.8% of the believed population at large, our exploitation and use estimates are likely reflective of actual exploitation and use; however, a larger sample size will be need to decrease variance and get a more accurate estimate of exploitation and use.

The Stanley Lake Fishery Management Plan directs the removal of fertile (diploid) Lake Trout and the stocking and introduction of sterile (triploid) Lake Trout to maintain a trophy Lake Trout fishery in Stanley Lake. The first component of the Stanley Lake Management Plan, the commercial removal of fertile Lake Trout, will be implemented in spring 2020. Using our telemetry results, commercial Lake Trout removal will likely be extremely successful due to the proposed amount of net they will set (≈37 m/ha), and our new found knowledge of common depths and areas occupied by Lake Trout in Stanley Lake. For comparison, Stanley Lake has a surface area of 71.3 ha while Lake Pend Oreille is 38,300 ha. At peak removal netting effort for Lake Trout in Lake Pend Oreille, 22 m/ha was used. Net densities between 6 m/ha and 22 m/ha when coupled with an angler incentive program have reduced the density of Lake Trout in Lake Pend Oreille by 60% (Hansen et al. 2019, Dux et al. 2019). After commercial netting, some amount of annual netting effort may be needed to maintain a high proportion of sterile Lake Trout in Stanley Lake. Our netting effort in subsequent years will need to be based on number of wild Lake Trout removed by commercial netters from 2020 to 2022 and the of sterile individuals that are stocked from the Grace Hatchery and transplanted from Bear Lake. All fish stocked will receive a PIT tag and a t-bar anchor or spaghetti tag depending on size. This will represent an excellent opportunity to learn about growth, mortality, and exploitation by having known-age fish in the system as well as an exact count of sterile fish stocked into the system. When sterile fish from Bear Lake are stocked into the system, we recommend tagging a subset with acoustic tags equipped with mortality sensors to evaluate post-stocking survival. We also recommend monitoring of all other salmonid populations in Stanley Lake at the conclusion of commercial netting.

MANAGEMENT RECOMMENDATIONS

1. As described in the Stanley Lake Management Plan, implement commercial netting targeting Lake Trout in 10-20 m depth range in 2020 through 2022.

2. Evaluate post-release survival of transplanted Lake Trout from Bear Lake via acoustic survival tag study.

3. Establish a regular monitoring program for all other fish species (besides Lake Trout) in Stanley Lake, using gillnets, to document trends in composition, relative abundance, and size structure.

4. Implement creel survey every 2-3 years after Lake Trout removal to gauge exploitation and catch rates of Lake Trout, Rainbow Trout, and kokanee.

Table 6. Summary statistics for Lake Trout captured during gillnet surveys at Stanley Lake, 2007 to 2019, including relative abundance (CPUE: fish/h), total length, and relative weights (W_r).

Year	Gillnet hours	*n*	CPUE	Mean TL (mm)	SE TL	Max TL	Mean W_r	SE W_r
2007	164.5	44	0.27	651.2	21.3	930	97.5	4.7
2010	111.5	18	0.16	689.0	42.2	915	94.1	3.6
2011	428.2	37	0.09	679.5	35.5	1,017	95.8	2.6
2012	4,069.5	203	0.05	551.1	14.5	1,005	93.7	2.6
2015	107.6	5	0.05	657.0	114.4	902	95.0	3.9
2016	472.4	38	0.08	606.4	29.2	1,083	87.7	1.7
2017*	210.3	78	0.09	469.8	20.7	904	89.9	1.2
2019*	220.8	72	0.08	516.4	17.7	878	88.1	1.1

*CPUE adjusted for net size

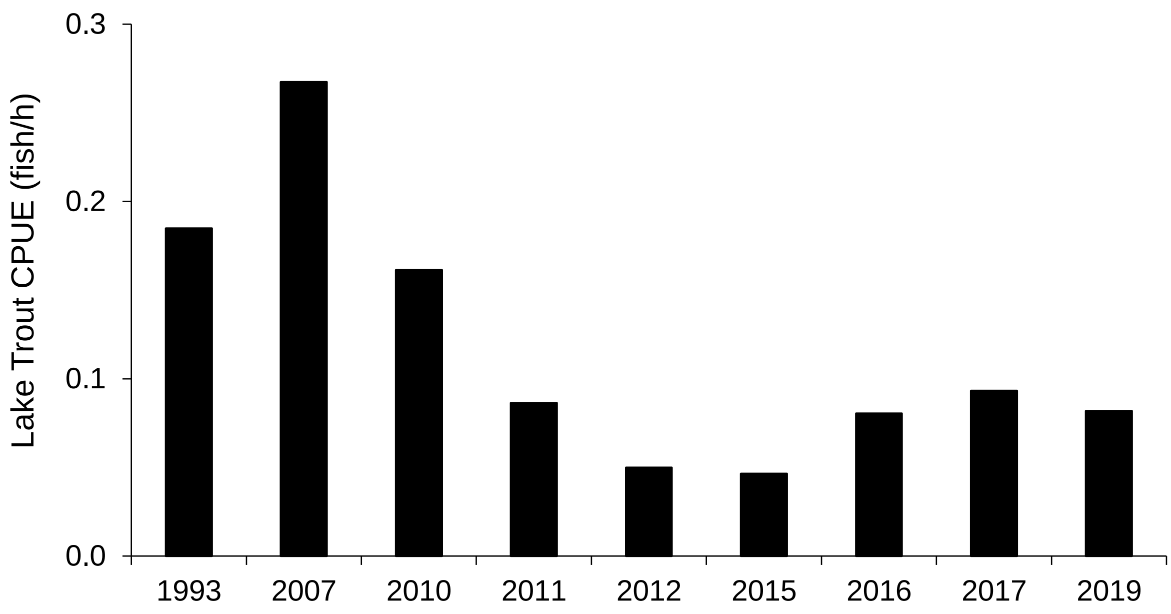

Figure 14. Stanley Lake gillnet CPUE (fish/h) for Lake Trout from 1993 to 2019. Years 2017 and 2019 are adjusted to reflect changes in net area.

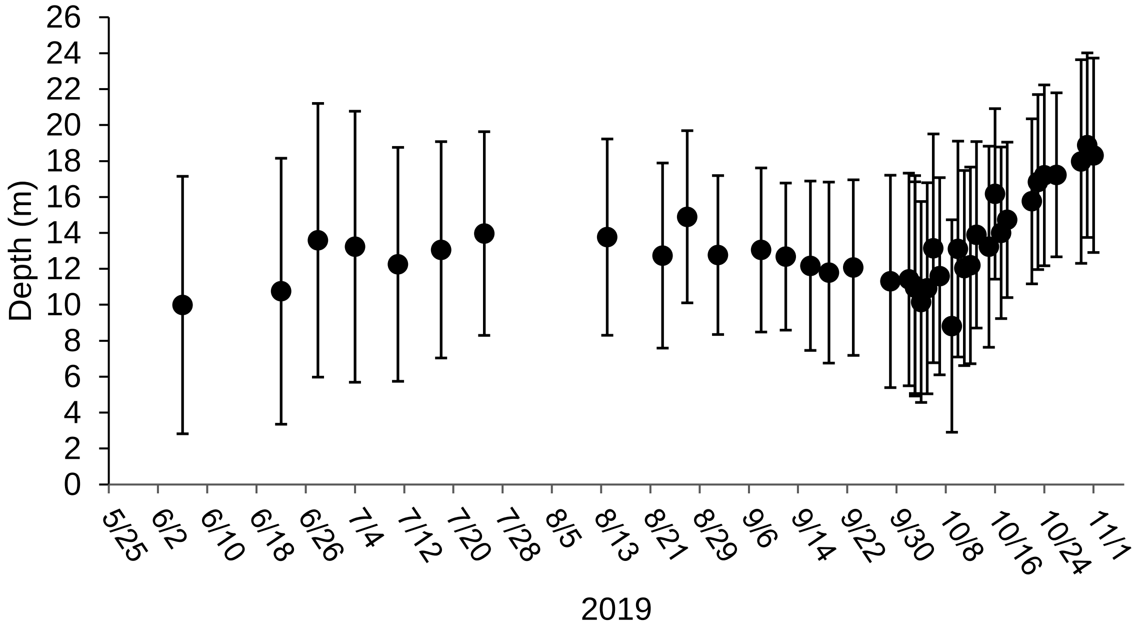

Figure 15. Average depth in meters (m) for Lake Trout at each tracking event at Stanley Lake in 2019. Error bars represent ± 1 standard deviation.

Figure 16. Locations of Lake Trout in Stanley Lake on July 4, 2019. Blue balloons represent individual Lake Trout and white numerals represent depth in meters.

Figure 17. Locations of Lake Trout in Stanley Lake on October 26, 2019. Blue balloons represent individual Lake Trout and white numerals represent depth in meters.

Figure 18. Locations of Lake Trout in Stanley Lake on October 31, 2019. Blue Balloons represent individual Lake Trout and white numerals represent depth in meters.

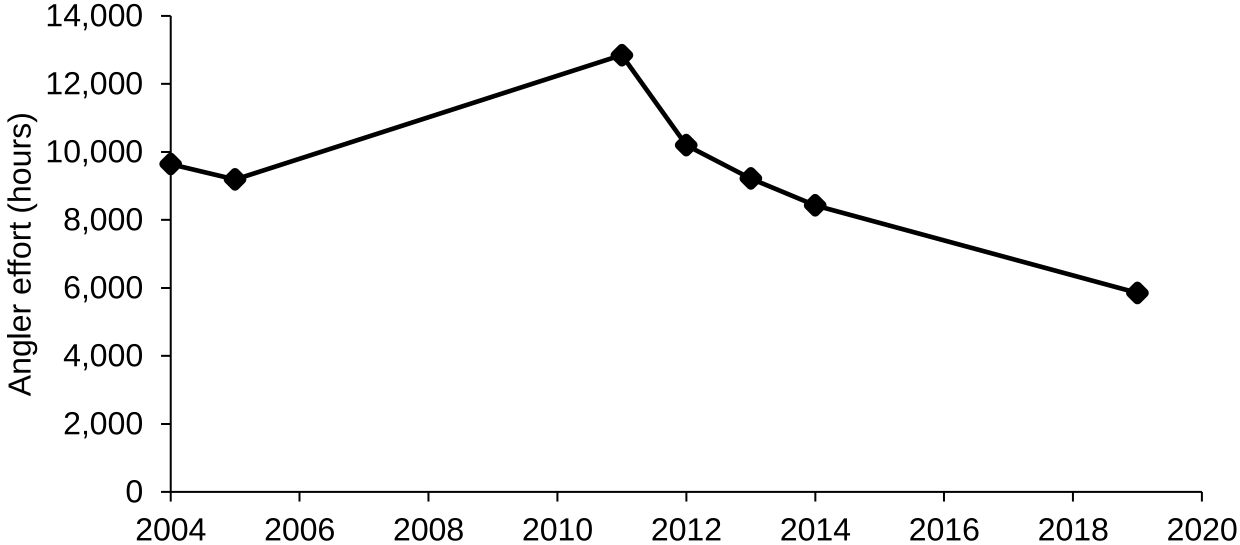

Figure 19. Angler effort estimated in angler hours during creel surveys conducted at Stanley Lake from 2004 to 2019.

CARLSON LAKE

ABSTRACT

Naturally reproducing populations of trout in high mountain lakes (HML) often experience stunted size structure due to density dependence. Reducing fish densities, especially in simple fish communities will often lead to increase growth rates and improved size structure. Often a predator is introduced to serve as a biological control to decrease abundance and increase size structure. Tiger muskellunge *Esox masquinongy x E. lucius* were stocked on four occasions from 2002 to 2018 in Carlson Lake as a biological control for Brook Trout *Salvelinus fontinalis*. Since 2002, Brook Trout and tiger muskellunge populations have been monitored periodically to evaluate the success of the program. In 2019, we performed routine monitoring of Carlson Lake which included a mark-recapture population estimate of Brook Trout, calculation of relative abundance, and size structure. Brook Trout were sampled and marked via angling and electrofishing in Carlson Lake during June, 2019. A total of 132 Brook Trout were then subsequently captured via gillnets with an average catch rate of 2.38 fish/h (SE = 0.82). Brook Trout ranged in TL from 114 to 358 mm with an average length of 230 mm (SE = 1.9). Overall Brook Trout abundance was estimated to be 13,411 (95% confidence interval = 4,343 – 22,479) in 2019. A total of 27 tiger muskellunge was sampled in Carlson Lake during June, 2019 (i.e., 26 via electrofishing and 1 via gillnet). Tiger muskellunge ranged in length from 730 to 1,022 mm and averaged 855 mm (SE = 22.00). Data collected in 2019 indicates that tiger muskellunge have been marginally successful in reducing Brook Trout abundance and improving size structure. However, we increased stocking density of tiger muskellunge in 2018 and should allow time for the increased density to take effect. Therefore, we recommend that changes to stocking density of tiger muskellunge into Carlson Lake be evaluated after the next survey in 2022. Additionally, we recommend that both the Brook Trout and tiger muskellunge population be monitored on years immediately prior to stocking and the years immediately after stocking. In addition to monitoring Brook Trout and tiger muskellunge in 2019, we estimated 503 hours of angling effort at Carlson Lake using remote cameras in an effort to gauge the amount of angler use at Carlson Lake.

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INTRODUCTION

Carlson Lake contains a naturally reproducing Brook Trout *Salvelinus fontinalis* population originating from stocking events in the 1940s and 1950s. An interdepartmental memo authored by Kent Ball in 1975 suggests Brook Trout weights up to 1.4 kg were documetned after the initial stockings (Salmon Region, IDFG records). Carlson Lake was also stocked with Rainbow Trout *Oncorhynchus mykiss* in 1975 and 1993 but these stockings were unsuccessful. Since 1975, surveys have indicated that the Brook Trout population in Carlson Lake exhibits density dependence (Messner et al. 2016). Efforts to reduce Brook Trout abundance have included intensive gillnetting, electrofishing, explosives, and increased bag limits. Tiger muskellunge were first introduced in 2002 to reduce the abundance of Brook Trout when 41 were stocked. Additionally, 32 tiger muskellunge *Esox masquinongy x E. lucius* were stocked in 2006, 70 in 2013, and 105 in 2018. This has resulted in the mean total length (TL) increasing from 201 mm in 2002 to a maximum of 272 mm in 2016.

We have never performed a creel survey on Carlson Lake. Anecdotally it appears to be one of our more popular small lakes, especially since the introduction of tiger muskellunge. However, due to the remote location and distance from Salmon, operating a traditional creel survey is impractical. Therefore, we employed a novel method to estimate relative angler effort at Carlson Lake in 2019.

OBJECTIVES

1. Monitor Brook Trout abundance and size structure to determine whether tiger muskellunge introduction has been effective at improving the quality of the fishery.

2. Estimate angler effort at Carlson Lake.

STUDY SITE

Carlson Lake (WGS84 datum: 44.28153º N, 113.75283º W) is a subalpine lake approximately 3.5 ha in surface area located in the Pahsimeroi River drainage at 2,438 m elevation. Subterranean flow from the lake drains into Double Springs Creek, a tributary of the Pahsimeroi River, but there is essentially no outlet and the inlet flow is seasonally intermittent. Carlson Lake has a highly vegetated littoral zone that extends for an average of approximately 12 m from shore and averages around 1 m deep, around the entire perimeter of the lake. Numerous spring upwellings occur in the littoral region of the lake.

METHODS

We used angling and raft electrofishing gear to capture Brook Trout on June 18-20, 2019. Angling was conducted during daylight hours, and raft electrofishing was conducted after sunset, with the aid of LED headlights mounted on the raft. All fish captured were measured for TL (mm), the anal or caudal fin was punched to mark the fish, and released alive.

On the evening of June 20, we set one pair of standard lowland lake gillnets (one sinking and one floating, per pair; 46 m long x 2 m deep, with six panels consisting of 19-, 25-, 32-, 38-, 51-, and 64-mm bar mesh) and one large sinking net 91.5 m long by 2 m deep, constructed from 0.38-mm-diameter light green twine, with three 30.5-m sections at 38-, 51-, and 64-mm stretch mesh, for the recapture event. Fish caught in gillnets were counted, measured (mm), weighed (g), examined for marks, and had their otoliths were removed. Otoliths were stored dry at the Salmon Regional Office for later analysis. Fish that were marked during angling and electrofishing and subsequently caught in gillnets were then used to calculate an abundance estimate. Brook Trout abundance was estimated using the two sample Lincoln-Petersen model (Ricker 1975) as:

$$\widehat{N} = \frac{MC}{R}$$

where $\widehat{N}$ is the total abundance, *M* is the number of fish marked during the first sampling event, *C* is the number of fish captured during the second sampling event, and *R* is the number of marked fish recaptured during the second sampling event.

We also calculated a Schnabel estimate using raft electrofishing gear to compare population estimation methods in an effort to possibly stream line future sampling. Brook Trout abundance was estimated using the Schnabel estimator (Ricker 1975) as:

$$N_t = \frac{\sum(C_t M_t)}{\sum R_t \ + 1}$$

where N_t is the total abundance at time *t*, C_t = total fish captured at time *t*, M_t = number of fish marked prior to sample period at time *t*, and R_t = number of fish marked captured at time *t*.

Length-frequency histograms were constructed for Brook Trout captured by gillnet. Brook Trout captured via gillnet were also used to calculate the proportional stock density (PSD) of Brook Trout ≥ 250 mm (PSD ≥ 250 mm) for stock quality comparisons with previous years at Carlson Lake.

We calculated relative weights (W_r) to compare overall change in body condition throughout the study period. Standard weight (W_s) was calculated using intercept and slope values for Brook Trout (*a* = -5.186, *b* = 3.103; Hyatt and Hubert 2001) or tiger muskellunge (*a* = -6.126, *b* = 3.337; Rogers and Koupal 1997), then W_r was calculated for each fish:

$$Log_{10}(W_s) = a + b * \ Log_{10}(\text{total length (mm)})$$

$$W_r = \left(\frac{\text{weight (g)}}{W_s}\right) * 100$$

We estimated relative angler effort using two remote cameras set at Carlson Lake on May 16, 2019 until October 8, 2019. Cameras were set to not overlap but encompass the entire lake and capture one photo at the beginning of each hour. Photos were analyzed using program Timelapse 2 (Greenberg and Godin 2015). We enumerated the number of bank and boat anglers present during every photo captured. Anglers were considered boat anglers if they used any type of watercraft to float on the water. It was assumed that if an angler was captured in a photo that the angler fished for the entire hour after the photo. An hour interval was used due to battery and memory restrictions. Greenberg and Godin (2015) suggest using remote cameras as a method to enumerate anglers to form an instantaneous count and supplementing with traditional creel data to inform managers of total fishing effort. However, they suggest that angler counts taken via remote cameras can provide a useful relative effort index as we did here.

RESULTS AND DISCUSSION

A total of 586 Brook Trout were captured and marked via electrofishing, (n = 513) and angling (n = 73) in an effort to estimate population size. A total of 126 unmarked and 6 marked Brook Trout were then subsequently captured during 49.8 h of gillnetting with an average catch rate of 2.65 fish/h (SE = 0.66; Table 7; Figure 21). Based on this recapture rate, we estimated 13,411 Brook Trout (95% confidence interval = 4,343 – 22,479) in Carlson Lake in 2019. These results indicate that the Brook Trout population abundance is similar to 2018 when the Peterson estimate was 9,713 with upper and lower confidence limits of 5,751 and 13,675. Additionally, the Schnabel estimator, using mark and recaptures from the only electrofishing, produced a population estimate of 2,011 Brook Trout (95% CLs = 1,585 - 2,752). This was the first year of performing a Schnabel estimate. The estimate appears to be informative, however, due to the large littoral zone at Carlson Lake and depths of up to 12 m, we don't feel that all fish were equally available to the gear. The lack of equal recruitment to the gear likely results in the disparity between the Peterson estimate and the Schnabel estimate.

Brook Trout ranged in length from 116 to 346 mm with an average length of 222 mm (SE = 0.97; Table 7; Figure 20). Relative weight (W_r) averaged 82 (SE = 3.0). The proportion of Brook Trout that were captured via gillnet that were ≥ 250 mm was 0.14. Relative weight in 2019 was slightly increased from 2018; however, the proportion of Brook Trout captured via net that were ≥ 250 mm decreased to 0.14 from 0.26 in 2018. PSD was 0.5, with three Brook Trout being greater than or equal to the stock length of 300 mm.

During our monitoring of Carlson Lake, periodically from 2002 to 2019, we have continued to observe a pattern of reduced CPUE and increased mean TL in years we have surveyed that immediately following tiger muskellunge stocking (i.e. 2003, 2014, and 2019). In these years we observe a truncated size structure with very few, if any Brook Trout captured <170 mm TL, likely indicating that stocked tiger muskellunge reduce the population of Brook Trout size classes less than 170 mm TL immediately following stocking.

A total of 27 tiger muskellunge were sampled in Carlson Lake during June, 2019 (i.e., 26 via electrofishing and 1 via gillnet). Abundance estimates were not available for tiger muskellunge due to low sample size. Tiger muskellunge varied in length from 168 to 1,010 mm and averaged 724.6 mm (SE = 48.8; Table 8). Tiger muskellunge were not weighed during this survey due to a logistical error. However, they did appear to be in excellent condition as in previous years. We did observe one tiger muskellunge with a total length of 168 mm. This is much smaller than any fish that was measured in the 2018 stocking event (minimum TL = 230 mm). This fish may have been missed in stocking due to its size. Natural reproduction is extremely unlikely as Becker (1983) noted that the females are often fertile but the males are always sterile.

Lastly, a pattern of density dependence was observed in the previous year's data that indicates as catch rates decrease, the proportion of Brook Trout ≥ 250 mm and the mean total length of Brook Trout increase (Table 7; Figures 20, 21). This pattern was also observed this year. We observed a decrease in CPUE and an increase in mean total length when compared to 2018. However, the Lincoln-Peterson population estimate increased while proportion of Brook Trout ≥

250 mm and mean total length increased. This could be due to environmental conditions, lack of marks, or lack of gillnetting effort. Additionally, after examining length-frequency histograms of years immediately following a tiger muskellunge stocking event, it appears that size classes smaller than about 170 mm TL disappear from the yearly sample. This may be one of the mechanisms of reducing density dependence of the Brook Trout population at Carlson Lake. This is similar to what Koenig et al. (2015) found when tiger muskellunge were used to eradicate Brook Trout from high mountain lakes in Idaho. Stocking of tiger muskellunge at Carlson Lake is marginally successful in reducing density dependence. However, increasing the frequency or density of tiger muskellunge stocking may allow for further increases in the Brook Trout size structure. The current stocking regime is 100 tiger muskellunge every five years, which began in 2018. We recommend surveying again in 2022, analyzing results then possibly changing density of tiger muskellunge stocking based on those results. This will allow more time for the tiger muskellunge to have an effect on the size structure of Brook Trout in Carlson Lake.

The effort and expenses to conduct a yearly population estimate at Carlson Lake are relatively high. This effort alone required nearly 400 staff-hours as well as additional equipment and food costs. We now understand the dynamics of predator-prey interaction in Carlson Lake, and we recommend changing the sampling regime to gillnet monitoring on the year immediately prior to stocking and year immediately post-stocking using standardized lowland lake gillnets to monitor changes in size structure and CPUE. Tiger muskellunge are easily sampled via boat electrofishing and size structure and abundance should also be assessed on these years as well.

We estimated 503 hours of angling effort at Carlson Lake (Table 9). Shore angler effort was substantially higher than boat angler effort. Shore anglers accumulated 424 hours of angling effort as opposed to boat anglers who accounted for 79 hours of angling effort. Angling effort was highest in July with 175 hours estimated (Table 9). Most boat anglers were observed using float-tubes; however, we did observe anglers using rafts and paddle boards.

A similar creel survey was conducted at Wallace Lake in 2018, where 2,093 hours of angling effort were calculated during roughly the same time period (Messner et al. 2021, *in review*). Compared to Wallace Lake where anglers can drive directly to without four-wheel drive, the trail access to Carlson Lake is fairly difficult, requiring a short but fairly steep hike, horse ride, or a competent rider on an ATV/UTV. This difficulty along with Carlson Lake being more remote likely accounts for this large difference in angling effort. We recommend repeating this creel survey every three years to continue to monitor angling effort on Carlson Lake.

MANAGEMENT RECOMMENDATIONS

1. Survey again in 2022 before making changes to stocking density of tiger muskellunge.

2. Collect abundance and size structure information for Brook Trout and tiger muskellunge in Carlson Lake on years immediately pre- and post-stocking of tiger muskellunge.

3. Monitor angling effort every three years using methodology described above.

Table 7. Brook Trout relative abundance (CPUE) and size structure (mean TL mm, mean relative weight W_r, and proportion > 250 mm TL) gillnetted throughout the study period (2002 - 2019) at Carlson Lake, Idaho.

	Relative abundance				Size structure		
Year	Gillnet effort (h)	# caught	CPUE (fish/h)	Population estimate (min-max)	Mean TL (min-max; mm)	Mean W_r (± SE)	Prop ≥ 250 mm TL (± SE)
2002[a]	147.8	546	3.69	9,025 (10,576-11,065)	201 (109-276)	78 (± 0.8)	0.07 (± 0.02)
2003	416.9	562	1.35	9,063 (6,987-12,039)	209 (96-270)	59 (± 2.3)	0.06 (± 0.03)
2005	369.5	599	1.62	6,103 (4,196-9,262)	231 (145-290)	89 (± 1.8)	0.48 (± 0.08)
2006[a]	64.8	150	2.32	--	216 (127-301)	104 (± 2.5)	0.47 (±)
2008[b]	20.5	67	3.27		224 (154-270)	88 (± 1.5)	0.30 (±0.08)
2009	151.7	246	1.62	--	234 (136-312)	87 (± 2.0)	0.45 (± 0.07)
2011	132.7	287	2.16	--	218 (115-291)	80 (± 1.3)	0.26 (± 0.05)
2013[a]	172.5	825	4.78	10,867 (9,182-13,008)	220 (150-292)	75 (± 0.5)	0.32 (± 0.03)
2014[b]	3.5	35	10.0		226 (184-287)	80 (±0.3)	0.28 (±0.08)
2015	75.0	108	1.44	--	252 (165-289)	86 (± 1.5)	0.81 (± 0.08)
2016	82.7	67	0.81	2,682 (1,833-4,748)	272 (169-351)	95 (± 2.1)	0.78 (± 0.09)
2017	84.2	184	2.23	--	234 (151-397)	94 (± 1.9)	0.39 (± 0.08)
2018[a]	81.7	399	4.88	9,713 (5,751–13,675)	230 (114-358)	78 (± 0.4)	0.26 (± 0.02)
2019	49.8	132	2.65	13,411 (4,343 – 22,479)	235 (116-346)	82 (± 3.0)	0.17 (± 0.02)

[a]*Years that tiger muskellunge were stocked*
[b]*Angling only surveys. Gillnet effort is replaced with angling effort(h)*

Table 8. Mean TL (mm) and mean relative weight (W_r) of tiger muskellunge by sampling year (stocked in 2013 and 2018) at Carlson Lake, Idaho (2013 - 2019).

	Stocked in 2013					Stocked in 2018				
		Total length (mm)		Relative weight (*Wr*)			Total length (mm)		Relative weight (*Wr*)	
Year	n	Mean	Range	Mean	Range	n	Mean	Range	Mean	Range
2013	70[a]	333	(290-380)	--		--	--			--
2016	5	708	(647-770)	112	(100-122)	--	--			--
2017	7	795	(750-865)	115	(105-121)	--	--			--
2018	6	819	(730-870)	105	(92-120)	105[a]	248	(230-282)	112	(76-136)
2019	20	895	(795-1010)	--		--	351	(168-457)		--

[a] *Tiger muskellunge measured at the time of stocking*

Table 9. Estimated angling effort of shore anglers and boat anglers estimated from trail cam survey at Carlson Lake, Idaho from May 2019 to October 2019.

Month	Shore angler hours	Boat angler hours	Total angler hours
May	29	0	29
June	120	20	140
July	146	29	175
August	94	27	121
September	31	3	34
October	4	0	4
Total	424	79	**503**

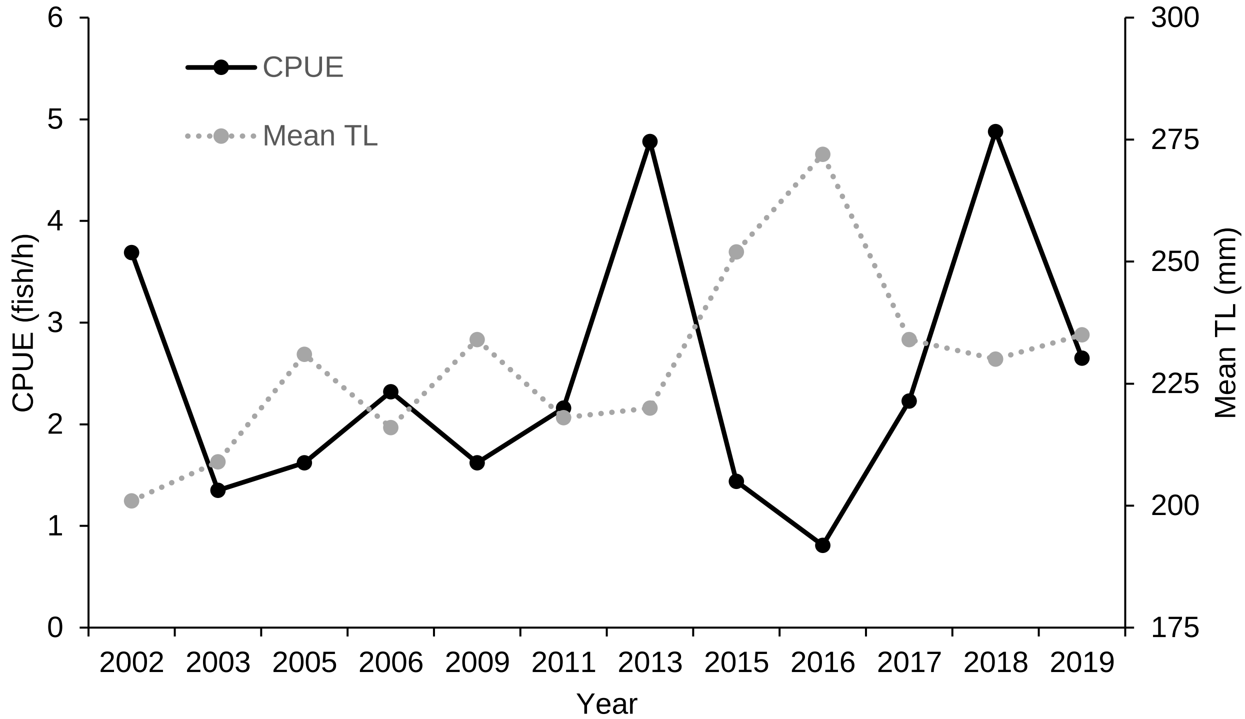

Figure 20. Relative abundance (CPUE) represented by black line (primary x-axis) and mean TL (mm) represented by gray line of Brook Trout sampled at Carlson Lake (secondary y-axis), Idaho, during the study period (2002 - 2019).

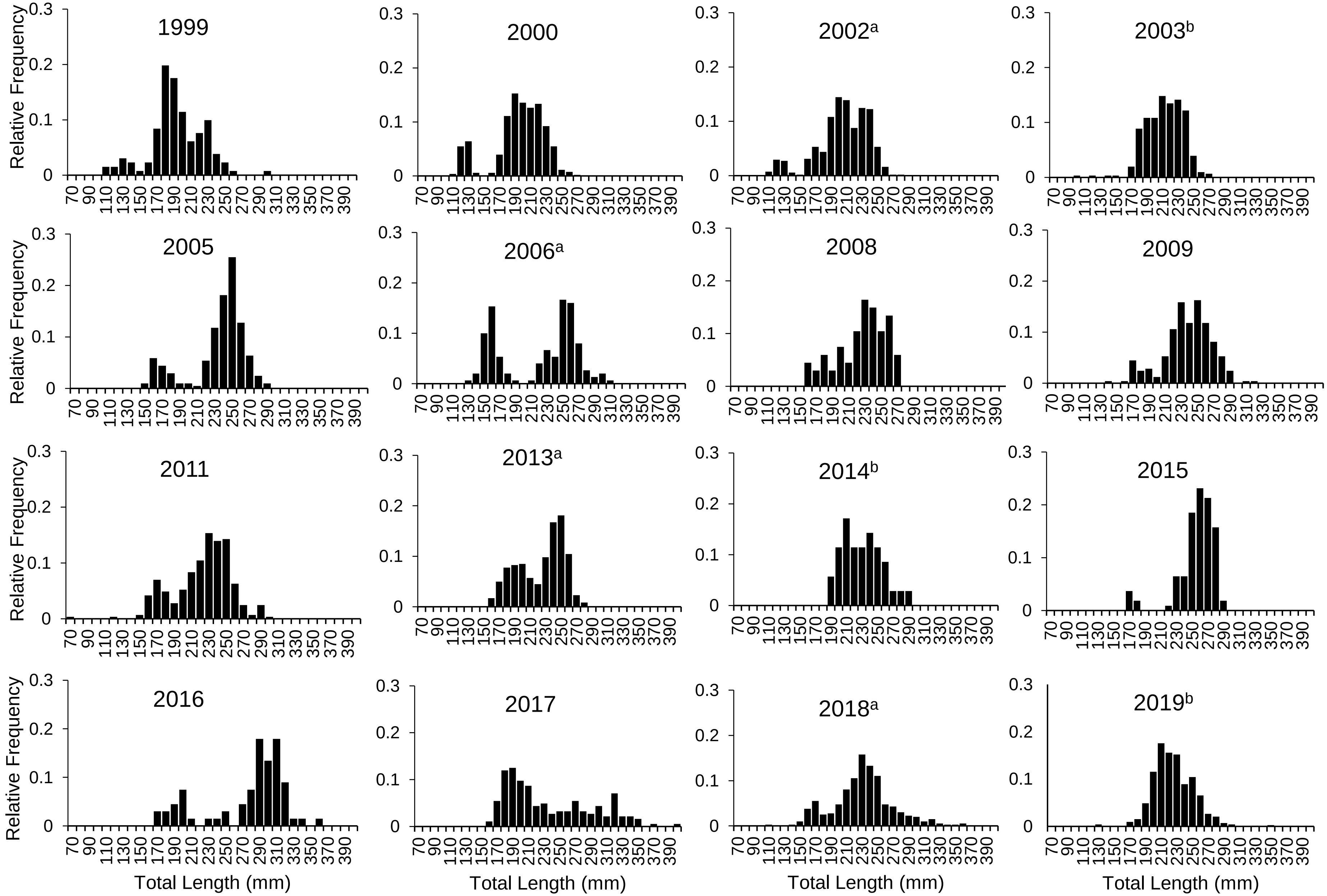

Figure 21. Length and relative frequency histograms of Brook Trout sampled at Carlson Lake from 199-2019. [a] Denotes years that tiger muskies were stocked. [b] Denotes years immediately after tiger musky stocking.

MIDDLE FORK SALMON RIVER TREND MONITORING

ABSTRACT

During July 2019, staff snorkeled 41 trend transects in the Middle Fork Salmon River (MFSR) drainage to determine fish species composition, length composition, size structure, abundance, and density. Thirty-two main stem MFSR transects and nine tributary transects were snorkeled. For main stem transects (n = 32), Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* had an overall mean density (± SE) of 1.7 fish/100 m^2 (± 0.21), Rainbow Trout /steelhead *O. mykiss* mean density was 0.47 fish/100 m^2 (± 0.18), and juvenile Chinook Salmon *O. tshawytscha* mean density was 1.01 fish/100 m^2 (± 0.47). In tributary transects (n = 9), Westslope Cutthroat Trout had an overall mean density of 0.63 fish/100 m^2 (± 0.18), Rainbow Trout/steelhead mean density was 0.29 fish/100 m^2 (± 0.10), and juvenile Chinook Salmon mean density was 0.29 fish/100 m^2 (± 0.17).

In 2019, 35% (n = 37) of the 105 Westslope Cutthroat Trout observed during main stem snorkel surveys were greater than 300 mm TL, compared to 13% in 1971 (prior to catch-and-release regulations implemented in 1972). Forty-one percent (41%) of Westslope Cutthroat Trout caught during angling surveys in 2019 were greater than 300 mm TL. That number has fluctuated from a low of 25% in 2007 to 53% in 1987, but has remained higher in the years since catch-and-release regulations began (1972) than during the four years of data we have prior. Average angler catch rate during surveys has remained relatively stable over the last twelve years (2.3 to 5.8 fish/h) and was 2.3 fish/h in 2019. Westslope Cutthroat Trout accounted for 67% of the total angler catch and Rainbow Trout/steelhead accounted for 27% in 2019.

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MIDDLE FORK SALMON RIVER

STUDY SITES AND METHODS

The Middle Fork of the Salmon River (MFSR) is part of the Wild and Scenic Rivers System and flows through the Frank Church River of No Return Wilderness in central Idaho. The MFSR originates at the confluence of Bear Valley and Marsh creeks near Cape Horn Mountain. It flows 171 km to its confluence with the Salmon River, 92 km downstream from Salmon, Idaho. The MFSR is a major recreational river offering a wide variety of outdoor and back-country experiences. The MFSR offers fantastic fishing opportunities in the main river and multiple tributaries for Westslope Cutthroat Trout *Oncorhynchus clarki lewisi*, as well as opportunities to catch Bull Trout *Salvelinus confluentus*. The number of people floating the river has increased substantially during the past 6 decades. In 1962, 625 people floated the MFSR. The United States Forest Service estimates that currently about 10,000 people/year float the river (USFS website 2020).

The earliest fishery study on the MFSR was conducted in 1959 and 1960. This study evaluated the life history and seasonal movements of Westslope Cutthroat Trout (Mallet 1963). A study in 1971 established snorkeling transects to be surveyed periodically (Corley 1972). Further studies were established in 1971 to evaluate catch-and-release regulations implemented in 1972 (Jeppson and Ball 1977, 1979). Our annual snorkel survey of the MFSR is now a continuation of a study started in 1985 to measure the densities of juvenile steelhead *Oncorhynchus mykiss,* Chinook Salmon *O. tshawytscha*, and Westslope Cutthroat Trout densities in the MFSR and its tributaries (Reingold and Davis 1987a, 1987b, 1988; Lukens and Davis 1989; Davis et al. 1992; Schrader and Lukens 1992; Liter and Lukens 1992). We also perform an annual angling survey to track trends of catch rates and average lengths, as well as periodically collect age and growth information. We have performed this survey annually since 2008, and it was previously performed sporadically from 1959 until 2008.

OBJECTIVES

1. Monitor Rainbow Trout/Steelhead, juvenile Chinook Salmon, and Westslope Cutthroat Trout densities within the MFSR and its tributaries to evaluate long-term trends in population status.

2. Monitor angling catch rates, particularly for Westslope Cutthroat Trout, to evaluate long-term trends relating to angler satisfaction.

3. Collect ageing structures from Westslope Cutthroat Trout to evaluate long term changes in age and growth.

Mainstem and Tributary Snorkeling Transects

Forty-two transects have been established and are sampled regularly to index abundances of populations, though not all transects are surveyed in all years. Six transects on the main stem MFSR were established prior to 1985 and are defined as historical (Corley) transects. Traditional transects were established after 1985 and consist of 28 main stem transects and 10 tributary transects. Main stem MFSR snorkeling transects and one tributary transect (i.e., Loon L1-Bridge) were sampled using corridor surveys described by Thurow (1982). Snorkeling was conducted by two snorkelers floating downstream with the current, remaining as motionless as possible, along both sides of the thalweg, with snorkelers observing directly ahead and toward the nearest bank. All species observed were documented. Length and abundance were estimated for all salmonids. The area surveyed for corridor sites was estimated by multiplying the length of the snorkeled transect by the visible corridor (i.e. visibility) and then multiplied by the number of snorkelers at each site (e.g., 111 m length x 2.2 m visibility x 2 snorkelers = 488.4 m^2). Visibility was measured at each site by suspending a sighting object (i.e., a sandal), in the water column and allowing the snorkeler to drift downriver until the object was unidentifiable. The snorkeler then moved upriver until the object reappeared clearly. The measured distance (m) between the object and the observer's facemask was the visibility. Fish densities were calculated by dividing estimated abundance by the area of the site and then multiplying by 100 (e.g. 4 fish / 488 m^2 x 100 = 0.82 fish/100 m^2).

Tributary snorkeling transects were sampled using techniques described by Apperson et al. (2014). Snorkeling was conducted by two to four snorkelers. The number of snorkelers depended on the width of the stream channel, water clarity (i.e. visibility), and the amount of obstructions in the stream channel (e.g., log jams). Visibility was measured at each site by suspending a sighting object (i.e., a sandal), and allowing the snorkeler to drift downriver until the object was unidentifiable. The snorkeler then moved upriver until the object reappeared clearly. Snorkelers were positioned so that bordering snorkelers were visible to each other while surveying. Once in position, snorkelers moved slowly upstream and fish were counted once the snorkelers passed the fish. All species observed were documented. Length and abundance of salmonids were estimated. The area of each survey was calculated by taking stream width measurements (i.e. ≥ 3) at approximately 10-m intervals along the length of the transect. The average width is then multiplied by the transect length to calculate surveyed area (average width of 3 m x 100 m length = 300 m^2). Fish densities were calculated using the same methodology as was used for the mainstem MFSR sites.

Project Angling

The primary objective of 'project angling' is to evaluate current trends in angler catch rates and sizes of fish captured. Project anglers used fly-fishing and conventional spinning tackle to gather catch rate and fish size information on 152.5 km of the main stem MFSR from Boundary Creek to the confluence with the Salmon River in 2019. Anglers recorded data including the exact amount of time fished, gear type used, total length and species of their catch. These data were added to an existing trend dataset that has been sporadically maintained since 1959, and consistently maintained since 2008. Additionally, we extracted otoliths from a subset of Westslope Cutthroat Trout to evaluate growth and mortality of the population. Otoliths were extracted in the field, cleaned of debris, and stored dry, in vials. Otoliths were then mounted in epoxy, cross sectioned, and aged with a compound microscope (Leica). We used back calculated length at age to compare growth rates to previous years of data and produce a von Bertalanffy growth function (von Bertalanffy 1938) We also estimated annual survival (S) and annual mortality (A) using methods described in Hubert and Quist (2010) and Program R (2017) code provided by Ogle in the R package ("FSA").

Pacific Lamprey Sampling

In 2019, 18 sites were surveyed for Pacific Lamprey *Entosphenus tridentatus* ammocoetes using a Smith Root™ LR-24 electrofishing backpack (Table 15) using dual-pulse settings of 300V for both pulses. Lamprey were enumerated and measured to nearest mm. A tissue sample was taken for genetic analysis.

RESULTS AND DISCUSSION

Main stem and Tributary Snorkeling Transects

Five of six MFSR historical (Corley; Corley 1972) transects, 27 of 28 traditional main stem transects, and nine of 10 traditional tributary transects were snorkeled between July 17 and July 24, 2019. Boundary (a traditional main stem transect) was snorkeled improperly by the seasonal snorkel crew (i.e., entire width, not a corridor survey) and thus was not included in the analysis. Furthermore, neither Cliffside Pool (a historical main stem site), nor Big Creek L1 (a traditional tributary site) were snorkeled in 2019 as both sites were deemed too dangerous to safely snorkel.

Mean densities (± SE) at traditional main stem transects in 2019 were 1.72 fish/100 m^2 (± 0.35) for Westslope Cutthroat Trout, 0.87 fish/100 m^2 (± 0.39) for Rainbow Trout/steelhead, 0.13 fish/100 m^2 (± 0.11) for Chinook Salmon parr, 0.01 fish/100 m^2 (± 0.01) for Bull Trout, 0.38 fish/100 m^2 (± 0.38) for trout fry, and 1.14 fish/100 m^2 (± 0.29) for Mountain Whitefish. No Brook Trout were observed (Table 10). Mean fish densities at historical main stem (Corley) sites snorkeled in 2019 were 1.51 fish/100 m^2 (± 0.19) for Westslope Cutthroat Trout, 0.26 fish/100 m^2 (± 0.13) for Rainbow Trout/steelhead, and 0.81 fish/100 m^2 (± 0.30) for Mountain Whitefish. No Brook Trout, Chinook Salmon parr, Bull Trout, nor trout fry were observed (Table 10). In the nine traditional tributary transects we snorkeled in 2019, densities averaged 0.99 fish/100 m^2 (± 0.42) for Westslope Cutthroat Trout, 0.45 fish/100 m^2 (± 0.14) for Rainbow Trout/steelhead, 0.11 fish/100 m^2 (± 0.08) for Chinook Salmon parr, 0.02 fish/100 m^2 (± 0.02) for Bull Trout, 0.02 fish/100 m^2 (± 0.02) for Brook Trout, 0.02 fish/100 m^2 (± 0.02) for trout fry and 0.91 fish/100 m^2 (± 0.26) for Mountain Whitefish (Table 10).

For anadromous parr in traditional mainstem transects, snorkel densities in 2019 were low which is to be expected considering the recent period of relatively low spawner escapement in the basin (Felts et al. 2019). This is evident in mean densities for Chinook Salmon parr across all main stem traditional sites in 2019 (0.13 ±0.11) when compared with the long term average density (i.e., 1986 – 2018; 3.89 ± 1.28). Rainbow Trout/steelhead density was also lower across all main stem traditional sites in 2019 (0.87 ± 0.39) than the long-term average density (i.e., 1986 – 2018; 1.03 ± 0.23) (Table 10).

Westslope Cutthroat Trout snorkel densities in traditional mainstem MFSR sites in 2019 (1.72 ± 0.35) were lower than the long-term average (1986 – 2018 = 1.94 ± 0.32; Figure 21). Whereas, Westslope Cutthroat Trout snorkel densities in tributary sites (0.99 ± 0.42) were about one half of the long-term average (1985 – 2018 = 1.89 ± 0.41; Figure 22). Since 1986 when the first snorkel surveys were completed at MFSR traditional sites, the percent of WCT greater than 300 mm has varied from 13 to 60% with an average of 32% during the time period. In 2019, 35% (*n* = 37) of the 105 Cutthroat Trout observed during snorkeling were estimated to be greater than 300 mm TL in traditional mainstem MFSR transects (Figure 23).

Project Angling

Project anglers caught 467 fish from the mainstem MFSR during angling surveys in 2019 (Table 13). Westslope Cutthroat Trout accounted for 67% of our total catch (*n* = 324) whereas Rainbow Trout/steelhead accounted for 27% (*n* = 131; Table 14). Northern Pikeminnow *Ptychochelius oregonensis*, suckers Catostomus *spp*, Redside Shiner *Richardsonius balteatus*, Bull Trout, and Westslope Cutthroat Trout × Rainbow Trout hybrids accounted for the remaining 6% (*n* = 28; Table 14). Between 2009 and 2019 when we began recording angling effort times, CPUE has fluctuated between 2.8 - 5.8 fish/h (mean = 3.7 fish/h). In 2019, angler catch-per-unit-effort (CPUE) was 2.3 fish/h (Table 13; Figure 24).

Prior to catch-and-release regulations going into effect in 1972, the mean proportion of Westslope Cutthroat Trout caught by project anglers greater than 300 mm TL was approximately 20%. Since the regulation change, this proportion has fluctuated annually, varying from a low of 25% in 2007 to a high of 53% in 1987 (mean = 38.5%; Figure 25). In 2019, the proportion of Westslope Cutthroat Trout larger than 300 mm TL caught by project anglers was 41% (*n* = 349; Table 14; Figures 24,25). Annual fluctuation of this value could be partially attributed to differences in angler skill level, gear type, sample timing, river discharge, temperature, and water clarity. However, this value has remained relatively stable since 2010 (Figure 24). The overall size structure of WCT is balanced with peaks observed at 270, 320, 340, and 350 mm length bins (Figure 26). However only two fish were caught that measured greater than 400 mm. This truncated size structure may also be indicative of density dependence in that very few fish appear to be growing beyond 350 mm before they succumb to natural mortality.

In 2019, project anglers logged the most hours of recorded angling effort since project angling began at 203.1 h, and caught 467 fish. Contrary to previous years, our CPUE increased on the last day of angling. This is likely due to cooler than average water temperatures in the lower section of the river. However, the proportion of WCT greater than 300 mm was higher than in 2017 and 2018 when the CPUE values were 3.5 fish/h for both years. A similar trend can be seen since 2008 when CPUE of WCT and the percentage of WCT over 300 mm are compared (Figure 27). This may suggest that there is density-dependence in the Middle Fork Salmon River Westslope Cutthroat population.

We collected otoliths from sixty-nine Westslope Cutthroat Trout in 2019 to estimate age, growth, and mortality. We were not able to accurately estimate survival in 2019 due to the youngest fish in our sample being age-4, which gave us an annual mortality rate (A) from age 4-8 of 67.4%. We believe this is an overestimation and annual mortality is likely closer to 40% as previously reported in Messner et al. (2017a). We used mean back calculated length at age in our sample to produce a von-Bertalanffy growth function using FAMS (FAMS; Table 16; Figure 28). L-infinity, also known as the average maximum theoretical length obtainable, was estimated to be 397.8 mm. The growth constant (K) was estimated to be 0.2, and t_0 was estimated to be -0.01. We also compared length-at-capture and length-at-age to surveys conducted in 1959-1960 (Mallet 1963), 2004 (Meyer and Elle 2004), and 2015 (Messner et al. 2017). We likely overestimated age by counting an internal annulus compared to Meyer and Elle (2004) and Messner (2015); therefore, we subtracted one year from our final age at capture estimates (Table 16). When mean back calculated length at age from 2019 is compared to WCT in 1959-1960 (Mallet 1963), we see that growth to age 3 in 2019 is faster than growth to age 3 for WCT in 1959-1960. Whereas growth for older ages appears to have slowed as the length at annulus 6 being 371 mm for the sample in Mallet (1963) compared to 310 mm for the sample in 2019. These results suggest that growth for younger fish in the tributaries remains similar or higher to then, but that growth in the river is much slower now. Additionally, more fish are living longer, due to the lower annual mortality as mentioned above. We recommend collecting otoliths from a minimum of 100 WCT annually for 3 years during each 10-year cycle to continue to track mean back-calculated length at age, which will allow us to observe the growth of individual cohorts through time and build a more robust age and growth dataset.

Growth of Westslope Cutthroat appears to be similar to 2004 and 2015 but slower than 60 years ago, with average size at ages up to age 3 being larger. However after age four, fish in the Mallet (1963) sample obtains a much larger length at annulus and length at capture than our sample (Mallet 1963; Table 16). The Mallet (1963) sample was taken before catch and release regulations were put into place, and fish may have been experiencing better growth due to lessened density due to exploitation. Additionally, 46% of Westslope Cutthroat Trout in 2019 were greater than 300 mm, compared to only 20% before catch-and-release regulations were imposed (Figure 25). This has produced one of the highest quality trout fisheries in the Salmon Region at present time. Hopefully with maintaining this dataset, we can detect any major community shifts that would affect the quality of the fishery and address them early.

The relative increase in proportion of larger Westslope Cutthroat caught since catch-and-release regulations went in place can mostly be attributed to reduced total annual mortality (particularly angling-related mortality) and higher abundance of Westslope Cutthroat Trout. Growth rates for Westslope Cutthroat Trout have actually decreased since the period prior to catch-and-release regulations (Messner et al. 2017a). However, more Westslope Cutthroat Trout are living to maximum age (~8 years) than prior to the regulation change. Prior to the change, mean annual survival was estimated at 32% (1959-1960; Mallet 1963), and in 2015 we estimated mean annual survival at 60% (Messner et al. 2017a). Despite the level of recreational use now present in the MF Salmon, the catch-and-release fishing regulations appear to be effective in keeping mortality rates low enough to maintain a high quality fishery.

Pacific Lamprey Sampling

In 2019, 18 sites were surveyed for Pacific Lamprey. No Pacific Lamprey were captured at any sites in 2019 upstream of the confluence of Cub Creek and the Middle Fork Salmon River using a Smith Root™ LR-24 electrofishing backpack (Table 15). Pacific Lamprey were sampled at 9 of 18 sites (50%; Table 15). In total, 396 Pacific Lamprey were sampled across all sites and length varied from 30 to 140 mm. Tissue samples were taken for all sampled Pacific Lamprey for genetic analysis.

MANAGEMENT RECOMMENDATIONS

1. Continue annual trend data collection on Westslope Cutthroat Trout, Rainbow Trout/Steelhead, and juvenile Chinook Salmon in the middle Fork Salmon River and tributaries through snorkeling. and electrofishing.

2. Continue annual trend data collection on Westslope Cutthroat Trout, Rainbow Trout/Steelhead, and juvenile Chinook Salmon in the middle Fork Salmon River and tributaries through angling.

3. Conduct age and growth analysis of WCT in MFSR for 3 consecutive years once every 10 years.

Table 10. Densities of salmonids observed during snorkel surveys in the MFSR Historical main stem (Corley) sites in 2019 (fish/100 m2).

Site	Transect length (m)	Trout fry	Rainbow Trout/ steelhead	Chinook Salmon parr	Cutthroat Trout	Bull Trout	Brook Trout	Mountain Whitefish
Little Creek GS	85	0.00	0.56	0.00	1.68	0.00	0.00	0.28
Mahoney	50	0.00	0.59	0.00	1.76	0.00	0.00	1.76
White Creek PB	300	0.00	0.13	0.00	0.80	0.00	0.00	0.40
Bernard Airstrip	100	0.00	0.00	0.00	1.46	0.00	0.00	1.25
Hancock Pool	120	0.00	0.00	0.00	1.83	0.00	0.00	0.33
Cliffside Pool	-	-	-	-	-	-	-	-
Mean	131	0.00	0.26	0.00	1.51	0.00	0.00	0.81
SE	43.8	0.00	0.13	0.00	0.19	0.00	0.00	0.30
Minimum	50	0.00	0.00	0.00	0.80	0.00	0.00	0.28
Maximum	300	0.00	0.59	0.00	1.83	0.00	0.00	1.76

Table 11. Densities of salmonids (fish/100m^2) observed during snorkel surveys in the MFSR Traditional main stem sites in 2019.

Site	Transect length (m)	Trout fry	Rainbow Trout / steelhead	Chinook Salmon parr	Cutthroat Trout	Bull Trout	Brook Trout	Mountain Whitefish
Boundary[a]	60	-	-	-	-	-	-	-
Gardell's	126	0.00	3.47	0.50	0.74	0.00	0.00	1.74
Velvet	37	0.00	10.17	0.00	6.78	0.00	0.00	2.54
Elkhorn	68	0.00	2.06	0.00	1.18	0.00	0.00	0.59
Sheepeater	102	0.00	0.91	0.00	1.09	0.00	0.00	0.54
Greyhound	99	0.00	0.00	0.00	0.58	0.00	0.00	0.00
Rapid River	74	0.00	1.53	0.00	1.23	0.00	0.00	2.15
Indian	137	0.00	0.15	0.00	3.07	0.00	0.00	1.75
Pungo	77	0.00	0.32	0.00	6.49	0.00	0.00	7.47
Marble Pool	142	0.00	1.01	2.85	4.03	0.00	0.00	3.02
Ski Jump	155	0.00	0.13	0.00	0.52	0.13	0.00	0.39
L. Jackass	111	0.00	1.35	0.00	4.50	0.00	0.00	1.35
Cougar	50	0.00	0.59	0.00	0.00	0.00	0.00	1.18
Whitey Cox	102	0.00	0.00	0.00	3.13	0.00	0.00	0.22
Rock Island	122	0.00	0.00	0.00	2.05	0.00	0.00	0.17
Hospital Pool	80	0.00	0.31	0.00	1.56	0.00	0.00	0.63
Hospital Run	66	0.00	0.00	0.00	0.00	0.00	0.00	0.76
Tappan Pool	137	0.00	0.00	0.00	0.84	0.00	0.00	0.14
Flying B	100	0.00	0.00	0.00	1.32	0.00	0.00	0.00
Airstrip	110	0.00	0.00	0.00	0.72	0.00	0.00	0.00
Survey	75	0.00	0.30	0.00	0.91	0.00	0.00	0.91
Big Creek PB	185	10.14	0.14	0.00	0.68	0.00	0.00	1.49
Love Bar	100	0.19	0.19	0.19	1.48	0.00	0.00	0.74
Ship Island	126	0.00	0.15	0.00	1.91	0.15	0.00	0.59
Little Ouzel	95	0.00	0.19	0.00	0.19	0.00	0.00	0.58
Otter Bar	143	0.00	0.13	0.00	0.91	0.00	0.00	0.65

Table 11 (continued)

Site	Transect length (m)	Trout fry	Rainbow Trout / steelhead	Chinook Salmon parr	Cutthroat Trout	Bull Trout	Brook Trout	Mountain Whitefish
Goat Pool	134	0.00	0.15	0.00	0.30	0.00	0.00	0.75
Goat Run	122	0.00	0.16	0.00	0.33	0.00	0.00	0.33
Mean	105	0.38	0.87	0.13	1.72	0.01	0.00	1.14
SE	6.6	0.38	0.39	0.11	0.35	0.01	0.00	0.29
Minimum	37	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	185	10.14	10.17	2.85	6.78	0.15	0.00	7.47

[a] Boundary site was surveyed incorrectly (entire width vs. corridor) thus the data have been omitted from this report.

Table 12. Densities of salmonids (fish/100 m^2) observed during snorkel surveys in the MFSR tributary sites in 2019.

Site	Transect length (m)	Trout fry	Rainbow Trout / steelhead	Chinook Salmon parr	Cutthroat Trout	Bull Trout	Brook Trout	Mountain Whitefish
Big Creek L1	-	-	-	-	-	-	-	-
Indian Lower	47	0.00	1.01	0.00	0.20	0.00	0.00	0.20
Indian Upper	58	0.00	0.38	0.13	0.13	0.00	0.00	0.13
Loon L1[a]	52	0.00	0.00	0.00	4.08	0.00	0.00	0.87
Loon L2	41	0.00	0.27	0.00	1.51	0.14	0.14	1.51
Camas L1	71	0.00	0.08	0.00	0.50	0.00	0.00	1.07
Camas Upper	37	0.00	0.17	0.00	0.34	0.00	0.00	1.87
Marble Lower	53	0.29	0.15	0.15	0.29	0.00	0.00	0.00
Pistol L1	35	0.00	0.81	0.00	1.42	0.00	0.00	2.03
Pistol L2	35	0.00	1.16	0.69	0.46	0.00	0.00	0.46
Mean	48	0.03	0.45	0.11	0.99	0.02	0.02	0.90
SE	4.0	0.03	0.14	0.08	0.42	0.02	0.02	0.26
Minimum	35	0.00	0.00	0.00	0.13	0.00	0.00	0.00
Maximum	71	0.29	1.16	0.69	4.08	0.14	0.14	2.03

[a] indicates that Loon L1 was surveyed using the corridor method, not the entire width method.

Table 13. Summary of numbers of fish caught, total effort and CPUE (fish/h) during angling surveys on the main stem MFSR, 1959 to 2019.

Year	WCT	RBT/ STHD	BLT	MWF	WCTx RBT	BUTx BKT	CHN	BKT	NPM	SUC	RSS	Total # of fish	Total hours of effort	CPUE
1959	143	112	11	0	0	0	0	0	0	0	0	266	UNK	n/a
1960	484	103	94	0	0	0	0	0	0	0	0	681	UNK	n/a
1969[a]	166	-	-	-	-	-	-	-	-	-	-	166	UNK	n/a
1975	158	109	11	4	0	0	0	0	0	0	0	282	57.5	4.9
1976	75	14	2	2	0	0	0	0	0	0	0	93	UNK	n/a
1978	160	91	0	13	0	0	0	0	0	0	0	264	86.0	3.1
1979	139	112	0	0	0	0	0	0	0	0	0	251	UNK	n/a
1990	735	339	2	0	0	0	0	0	0	0	0	1076	UNK	n/a
1991	42	54	0	0	3	0	0	0	0	0	0	99	UNK	n/a
1992	42	53	0	1	0	0	0	0	0	2	0	98	UNK	n/a
1993	242	66	0	0	6	0	0	0	0	0	0	314	UNK	n/a
1999	182	132	0	0	8	0	0	0	0	0	0	322	UNK	n/a
2003	167	91	0	0	0	0	1	0	0	0	1	260	UNK	n/a
2004	243	184	1	0	0	0	1	0	1	0	0	430	UNK	n/a
2005	226	157	7	2	4	0	0	0	5	0	0	401	UNK	n/a
2007	264	253	2	6	1	0	0	0	16	0	0	542	UNK	n/a
2008	64	90	0	0	1	0	0	0	0	0	0	155	26.9	5.8
2009	340	230	2	4	8	0	0	1	14	0	2	601	166.0	3.6
2010	174	115	8	21	3	0	2	2	0	0	0	325	116.2	2.8
2011	109	47	0	6	0	0	0	0	0	0	0	162	42.0	3.9
2012	299	206	11	14	4	0	0	0	5	1	1	541	145.9	3.7
2013	200	195	1	6	1	1	3	0	9	0	0	416	102.0	4.1
2014	167	137	3	7	1	1	0	0	6	3	2	327	98.7	3.3
2015	214	179	3	12	10	0	29	0	8	0	0	455	104.9	4.3
2016	270	192	0	2	11	0	0	0	9	0	2	486	156.5	3.1
2017	247	99	1	1	4	0	6	0	5	0	1	364	105.2	3.5
2018	116	93	1	1	3	0	0	0	1	0	0	215	61.3	3.5
2019	324	131	1	0	8	0	0	1	2	0	0	467	203.1	2.3

[a] only WCT enumerated

WCT = Westslope Cutthroat Trout, RBT/STHD = Rainbow Trout/Steelhead, BLT = Bull Trout, MWF = Mountain Whitefish, CHN = Chinook Salmon, BKT = Brook Trout, NPM = Northern Pikeminnow, SUC = Sucker spp., RSS = Redside Shiner.

Table 14. Percentage of each salmonid species represented in total catch during angling surveys on the mainstem MFSR, 1959 to 2019. Data from 1969 was omitted due to only enumerating WCT that year.

Year	WCT	RBT/STHD	BUT	BKT	MWF	WCTxRBT	BUTxBKT
1959	54%	42%	4%	0%	0%	0%	0%
1960	71%	15%	14%	0%	0%	0%	0%
1975	56%	39%	4%	1%	0%	0%	0%
1976	81%	15%	2%	2%	0%	0%	0%
1978	61%	34%	0%	5%	0%	0%	0%
1979	55%	45%	0%	0%	0%	0%	0%
1990	68%	32%	0%	0%	0%	0%	0%
1991	42%	55%	0%	0%	3%	0%	0%
1992	43%	54%	0%	1%	0%	0%	0%
1993	77%	21%	0%	0%	2%	0%	0%
1999	57%	41%	0%	0%	2%	0%	0%
2003	64%	35%	0%	0%	0%	0%	0%
2004	57%	43%	0%	0%	0%	0%	0%
2005	56%	39%	2%	0%	1%	0%	0%
2007	49%	47%	0%	1%	0%	0%	0%
2008	41%	58%	0%	0%	1%	0%	0%
2009	57%	38%	0%	1%	1%	0%	0%
2010	54%	35%	2%	6%	1%	0%	1%
2011	67%	29%	0%	4%	0%	0%	0%
2012	55%	38%	2%	3%	1%	0%	0%
2013	48%	47%	0%	1%	0%	0%	1%
2014	51%	42%	1%	2%	0%	0%	0%
2015	47%	39%	1%	3%	2%	0%	6%
2016	56%	40%	0%	0%	2%	0%	0%
2017	68%	27%	0%	0%	1%	0%	0%
2018	54%	43%	0%	0%	0%	1%	0%
2019	69%	28%	0%	0.2%	0%	2%	0%
Mean	58%	38%	1%	1%	1%	0%	0%

WCT = Westslope Cutthroat Trout, RBT/STHD = Rainbow Trout/Steelhead, BLT = Bull Trout, MWF = Mountain Whitefish, BKT = Brook Trout

Table 15. Date, site name, latitude, longitude, time samples (secs), and present or absent status of Pacific Lamprey sampling sites on the Middle Fork of the Salmon River in 2019.

Date	Site name	Latitude	Longitude	Time sampled (s)	Present/Absent	# captured
7/18	Saddle Camp	44.621774	-115.235118	270	Absent	0
7/18	1/4th mile below Dome Hole - Left Bank	44.654990	-115.165433	228	Absent	0
7/18	Across from Big Snag - Left Bank	44.696025	-115.150399	550	Absent	0
7/19	Indian Creek Air Strip	44.757341	-115.113229	721	Absent	0
7/19	Lower Jackass	44.722390	-114.961536	330	Absent	0
7/20	Mahoney Camp	44.758938	-114.897939	300	Absent	0
7/20	Left bank just above Whitey Cox at Hot Springs	44.782384	-114.862810	271	Absent	0
7/20	White Creek Camp	44.793085	-114.841232	380	Absent	0
7/20	Below Loon Creek	44.809261	-114.811157	378	Absent	0
7/20	Right bank below Cub Creek	44.841254	-114.772025	130	Present	16
7/20	Upper Grouse Camp	44.869885	-114.768283	222	Present	43
7/21	Camas Creek Camp	44.891553	-114.722468	187	Present	31
7/21	Funston Camp	44.909224	-114.732964	358	Present	52
7/21	Wilson Camp	45.032198	-114.724046	505	Present	46
7/22	Fly Camp	45.067616	-114.725954	531	Present	51
7/22	Cutthroat Cove	45.106104	-114.731334	673	Present	51
7/22	Parrot Placer	45.210385	-114.684315	180	Present	59
7/23	Otter Bar	45.238449	-114.662614	744	Present	48

Table 16. Mean length at age and mean back-calculated lengths at annulus for Westslope Cutthroat Trout sampled via hook and line in the Middle Fork Salmon River in 1959-60 (Mallet 1963), 2004 (Meyer and Elle 2004), 2015 (Messner et al 2017) and 2019. 2019 results were adjusted by subtracting one year to fit an overestimation of age in 2019 when compared to 2004 and 2015.

	1959-1960 (Mallet 1963)		2004 (Meyer and Elle 2004)	2015 (Messner et al. 2017)	2019	
Age	Length at annulus	Length at capture	Length at capture	Length capture	Length at annulus	Length at capture
1	--	--	--	--	116	--
2	100	206	179	220	169	--
3	174	258	217	218	212	233
4	254	308	226	281	243	241
5	322	368	263	309	280	288
6	371	406	341	324	310	338
7	--	--		355	308	315
8	--	--	--			

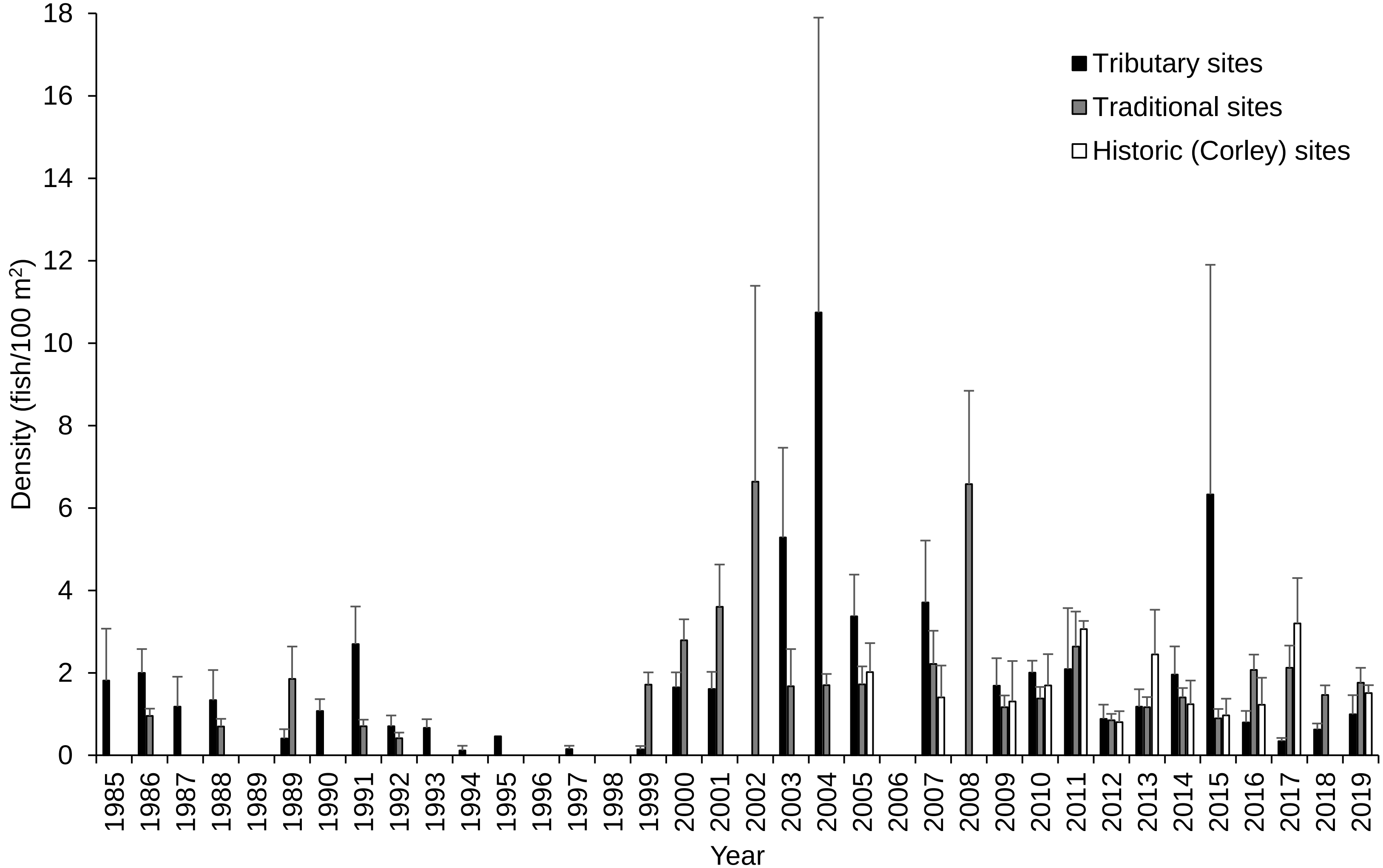

Figure 22. Average density of Westslope Cutthroat Trout (WCT) observed during snorkel surveys at MFSR Historic (Corley), Traditional, and Tributary transects. Error bars represent one standard error.

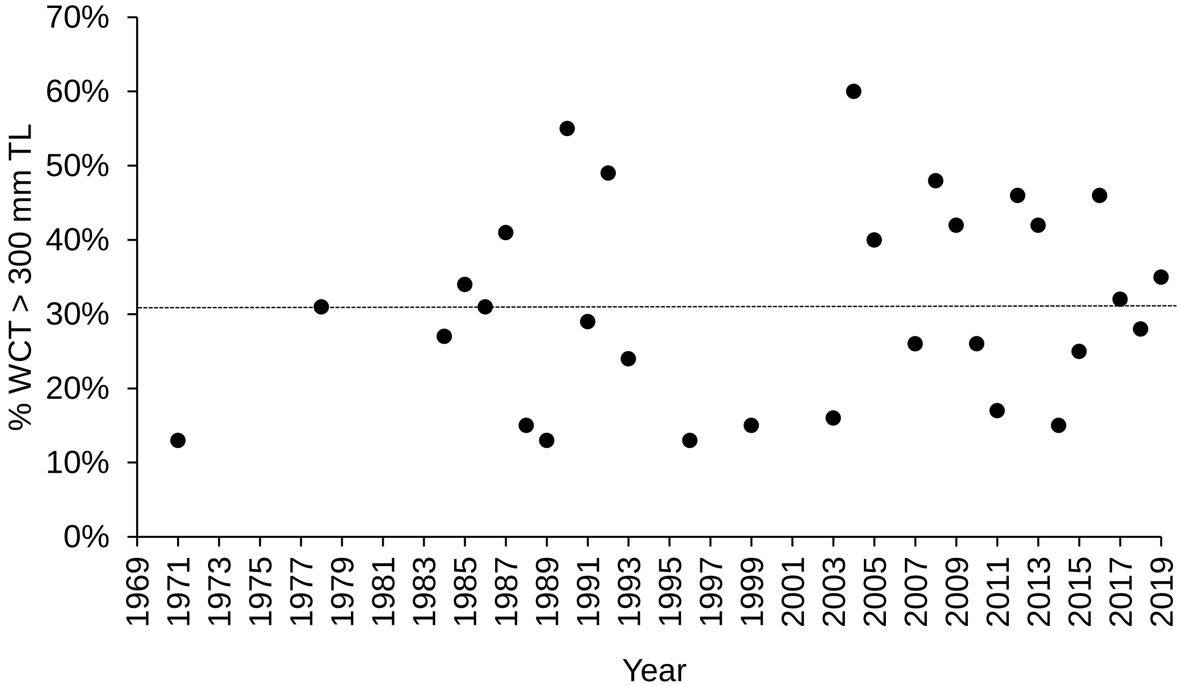

Figure 23. Percentage of Westslope Cutthroat Trout (WCT) greater than 300 mm TL observed during snorkel surveys in the main stem MFSR, 1971 to 2019. Dashed line represents the average (31%) during the same time period.

Figure 24. Catch per unit effort (CPUE) (# of fish caught per angler hour) estimated from hook and line sampling on the Middle Fork of the Salmon River between 2008 and 2019. The dotted line represents the mean (3.7 fish per angler hour) CPUE estimated over this time period.

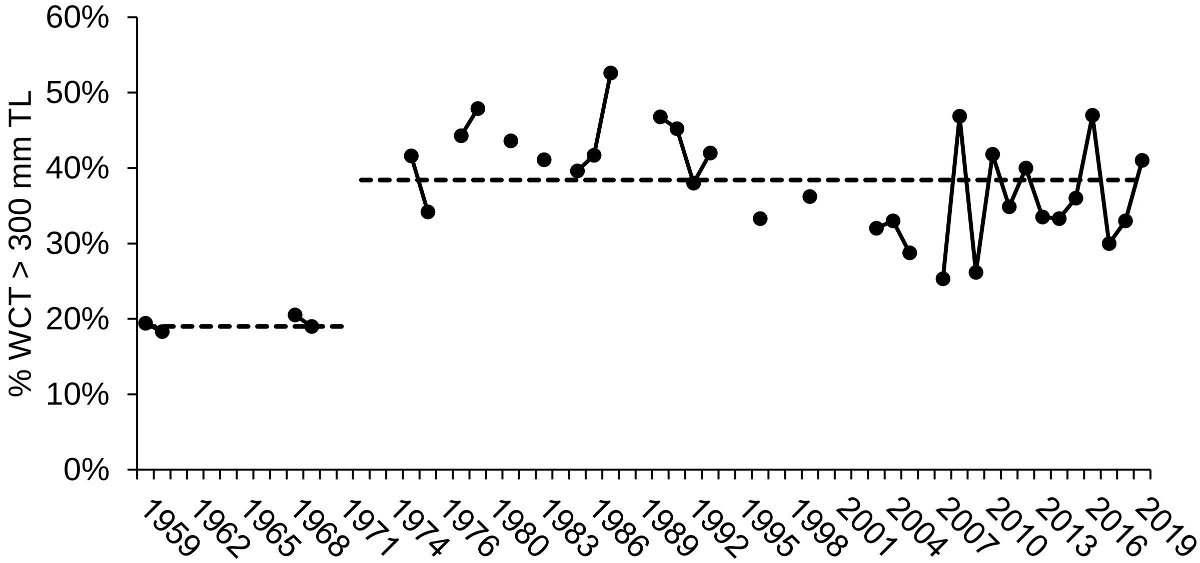

Figure 25. Percentage of Westslope Cutthroat Trout greater than 300 mm TL caught during angling surveys on the Middle Fork Salmon River, 1959 to 2018. The two dashed lines represent average proportions prior to 1972 (during harvest) and post-1972 (catch-and-release only).

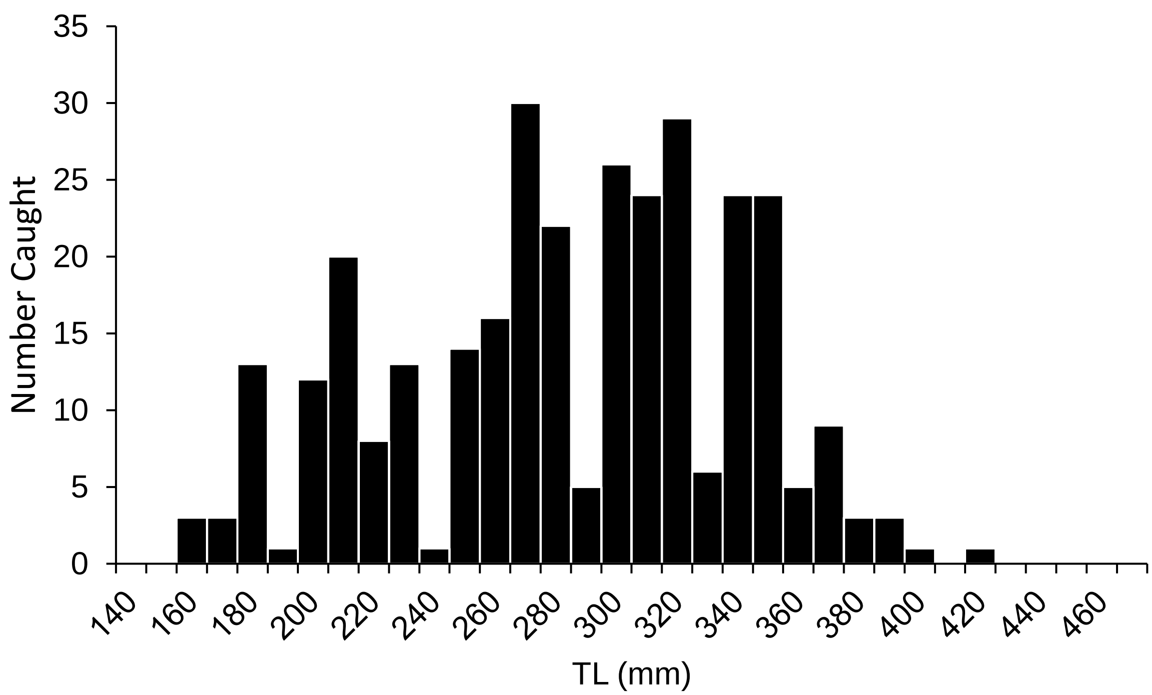

Figure 26. Length-frequency histogram of Westslope Cutthroat Trout caught during angling surveys in 2019 on the Middle Fork Salmon River.

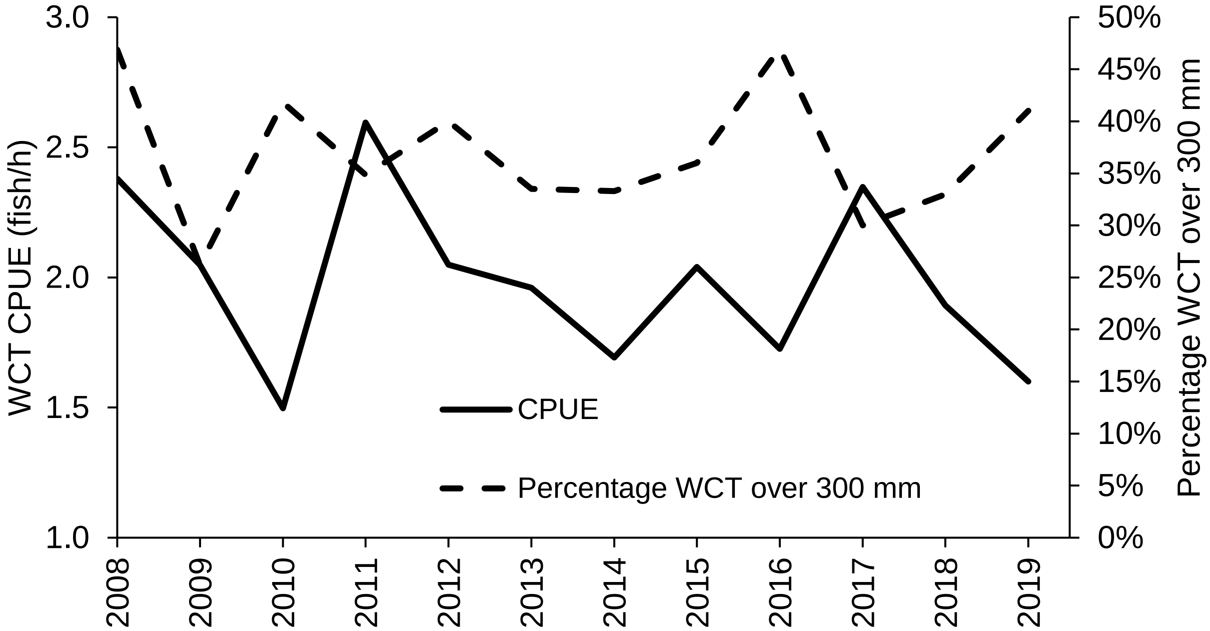

Figure 27. The angling CPUE (catch-per-unit-effort) of Westslope Cutthroat Trout (WCT) (fish/h) (solid line) and percentage of WCT caught over 300 mm (dashed line) during project angling in the Middle Fork Salmon River, from 2008-2019.

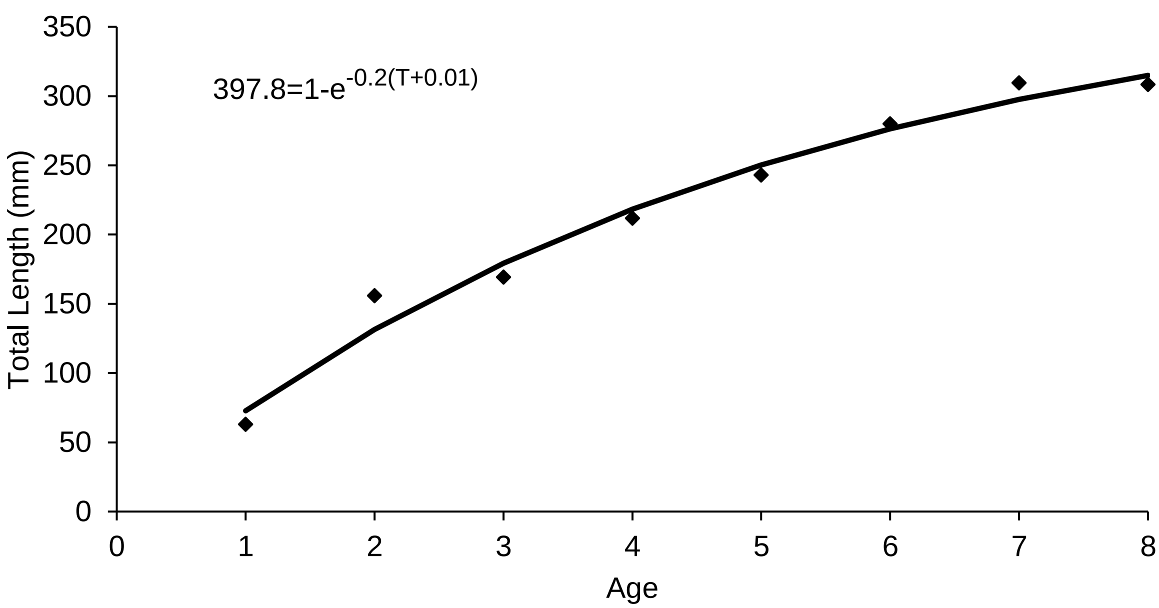

Figure 28. Von Bertalanffy model for back-calculated length at age of Westslope Cutthroat Trout sampled in 2019.

SALMON RIVER ELECTROFISHING SURVEYS AND CREEL

ABSTRACT

Raft-mounted electrofishing equipment was used to collect otoliths from Westslope Cutthroat Trout *Oncorhynchus clarkii* (WCT) for otolith microchemistry, and to determine fish composition, relative, distribution, and size structure in the Salmon River during the fall of 2019. Non-target species, including Mountain Whitefish *Prosopium williamsoni*, Northern Pikeminnow *Ptycheilus oregonensis*, various sucker species *Catastomus* spp., dace *Rhinichthys* spp., sculpin *Cottus* spp., Chiselmouth Chub *Acrocheilus* alutaceus, and Redside Shiners *Richardsonius balteatus* outnumbered target species in all transects we surveyed in 2019. However, non-target species were not netted or enumerated. We netted a total of 319 WCT during 14.0 hours of electrofishing in 2019 (CPUE 22.7 fish/h). Target species composition was 58% WCT, 9.7% *O. mykiss* parr (of which 100% were natural-origin), 12.2% Chinook Salmon *O. tshawytscha* parr (100% of which were natural-origin), 4.1% Cutthroat x Rainbow Trout hybrids, 2.8% Bull Trout *Salvelinus confluentus*, and 3.4% natural-origin *O. mykiss* > 300 mm TL (adult Rainbow Trout). Collected WCT otoliths are currently in preparation stage for later analysis.

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INTRODUCTION

The upper Salmon River already serves as a popular fishery for targeting anadromous Chinook Salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss*, but is under-utilized as a trout fishery. IDFG's current fisheries management plan lists "Improv[ing] the quality of Westslope Cutthroat Trout *O. clarkii*, fishing in the main stem Salmon River" as an objective (IDFG 2019). Our ability to improve trout fishing on the upper Salmon River is hindered by the fact that we currently know little about composition, abundance, movement, distribution, life history, and size structure of trout in the river.

The Salmon River supports a wide range of fish species, including anadromous salmon and steelhead, and several resident species including Rainbow Trout *O. mykiss*, Cutthroat Trout Bull Trout *Salvelinus confluentus*, Brook Trout *S. fontinalis*, Mountain Whitefish *Prosopium williamsoni*, Northern Pikeminnow *Ptycheilus oregonensis*, various sucker species *Catastomus* spp., dace *Rhinichthys* spp., sculpin *Cottus* spp., Chiselmouth Chub *Acrocheilus* alutaceus, and Redside Shiner *Richardsonius balteatus*. Electrofishing surveys conducted on the upper main stem Salmon River in 1998 found that suckers (var. spp.) and Mountain Whitefish (combined) made up 67% to 89% of the catch, while trout made up only 1% to 4% (Curet et al. 2000). In September 2016, we estimated combined density of Mountain Whitefish, Largescale Sucker, and Northern Pikeminnow below Deadwater at 1,289 fish/km, while combined density of O. mykiss and Westslope Cutthroat Trout was less than 10 fish/km (Messner et al. 2018).

Trout fishing in the upper Salmon River can be good during certain times of the year. During electrofishing surveys in 2015, we found that trout abundance in the upper Salmon River was higher in October sampling events than in September (i.e. abundance increased as main stem river temperature decreased) (Messner et al. 2017*b*). Other studies have also found that spatial distribution of trout throughout the upper main stem Salmon River varies seasonally, and is likely related to seasonal habits and requirements for each species such as spawning, foraging, and overwintering (Schoby 2006). Rainbow Trout, Bull Trout, and Westslope Cutthroat Trout in the Upper Salmon River drainage mainly spawn in smaller tributaries, but occupy various parts of the main stem river at other times of the year to optimize growth (e.g. overwintering). Recent PIT tag information collected throughout the Upper Salmon River drainage also shows that fluvial trout utilize smaller tributaries as thermal refugia during summer months, when main stem Salmon River water temperatures are elevated (Messner et al. 2021, *in review*). We have determined that sampling later in the fall, after the Salmon River water temperature decreases (i.e. October), increases our overall catch rates for fluvial trout (Messner et al. 2021 *in review*).

Prior to 2015, we possessed limited knowledge regarding the abundance, distribution, movement, and size structure of trout in the upper main stem Salmon River. Development and implementation of these electrofishing surveys has allowed us to gain a better understanding of relative abundance and distribution along the river corridor, seasonal movement and distribution, and size structure for trout and other target species. It has also raised interesting questions about the feasibility of using new research tools (i.e. otolith microchemistry, PIT tag technology) to learn more about the relative production and growth potential among tributaries of the upper Salmon River. Without knowledge on these subjects, it is difficult to make informed management decisions to improve the quality of trout fishing in the upper Salmon River. Annual sampling will allow us to monitor long-term trends of these populations, and evaluate the effectiveness of future management programs aimed at boosting trout abundance.

Angler use during steelhead and Chinook fisheries in the upper Salmon River is well documented and monitored, however little is known about anglers targeting trout species.

Therefore in 2019, we performed a creel survey on the upper Salmon River from Torrey's Campground upstream to Decker Flats in the Sawtooth Valley. To our knowledge, outside of the steelhead season creel surveys performed yearly, this was the first attempt at a creel survey to monitor resident trout angling effort on this section of the Upper Salmon River.

OBJECTIVES

1. Collect Westslope Cutthroat Trout for pilot study using hard part otolith microchemistry to examine natal origins of Westslope Cutthroat from Red Rock to Spring Creek.

2. Examine yearly differences in relative trout abundances, size structure, and species composition in established transects.

3. Continue PIT-tagging and recapture Bull Trout and Westslope Cutthroat Trout to examine growth and movement throughout the system.

4. Document angler use on the upper Salmon River from Decker Flats to Torrey's Campground.

STUDY SITES AND METHODS

Previous surveys have found that relative abundance of Westslope Cutthroat Trout in the reach of the main stem Salmon River between approximately the town of Salmon and the Middle Fork Salmon River increases later in the fall (Mallet, 1963; Schoby, 2006). Transects surveyed in 2019 were focused on the main stem Salmon River from 9.9 km downstream of the town of Salmon (Morgan Bar campground/boat launch) to Spring Creek (Figure 29). This stretch was chosen as part of a pilot study to determine the feasibility of using Westslope Cutthroat Trout for hard part otolith microchemistry analysis to determine natal tributary origin.

We performed single-pass electrofishing surveys on four transects in October and November 2019, including Morgan Bar to Red Rock (13.1 km), Red Rock to North Fork (8.7 km), Deadwater to Indianola (11.2 km), and Indianola to Spring Creek (10.3 km; Figure 29). The Morgan Bar to Red Rock and Deadwater to Indianola transects were both sampled in September 2016 and 2018, which provides some year-to-year comparisons. Morgan Bar to Red Rock was sampled in October and November, due to small sample size during the October sampling event.

All target fish were counted, measured (TL mm), weighed (g), checked for PIT-tags, and released, with the exception of untagged Westslope Cutthroat Trout which were sacrificed for use in the otolith microchemistry study. Any Bull Trout that was captured that did not already have a PIT tag received one. PIT tags used were Biomark APT12™ (12 mm x 2.03 mm). Recaptured PIT tag histories were queried from the ptagis.org database and summarized to observe the location where each fish was tagged and the most recent location they were observed at via PIT-tag detections or recaptures.

In previous years (since 2016) electrofishing surveys have been performed by two rafts working in tandem. Due to technical difficulties only one raft was mounted with Midwest Electrofishing Systems Infinity control boxes powered by Honda 5000-W generators. Pulsed DC current was applied to the water using two booms with Wisconsin ring anodes on each boat. Control box settings were between 200-350 volts, at a frequency of 60 Hz and 25% duty cycle, and typically between 4 – 8 amps and 1500 to 1800 watts. One fisheries technician on the front of each boat attempted to net all trout species, Chinook Salmon parr, steelhead parr, and any rare species encountered (e.g. Smallmouth Bass). Non-target species (Mountain Whitefish, Northern Pikeminnow, various sucker species, and Reside Shiners) were not netted because they were so abundant it would have taken away from our objective of collecting information on target species. If anadromous adults were encountered, electrofishing was halted, and resumed approximately 50 m downstream.

Untagged Westslope Cutthroat Trout were sorted and sacrificed while all remaining fish were anaesthetized using Aqui-S 20E fish anesthetic. All reporting requirements for using Aqui-S 20E as a trial anesthetic were followed (i.e. careful tracking of amounts used, fish handling times, and fish recovery times). Fish were identified, scanned for PIT tags, examined for other tags/marks, and measured (mm TL). All sacrificed Westslope Cutthroat Trout were weighed in the lab when otolith extractions took place. Otolith extractions occurred immediately upon return to the office on the day of sampling. All *O. mykiss* smaller than 300 mm TL (both steelhead and Rainbow Trout parr) were grouped together as *O. mykiss* juveniles, and those larger than 300 mm TL were grouped as Rainbow Trout. Adipose-clipped *O. mykiss* were considered hatchery origin steelhead, as we do not stock hatchery Rainbow Trout in the area. Untagged Bull Trout were marked with a PIT tag. All PIT tag information (marked or recaptured) was entered into ptagis.org. We also queried and summarized the PIT tag information for any recaptured individuals. The summaries include location where tagged, length at tagging, and the most recent location and date where individuals may have been detected or recaptured.

To summarize fish size and condition, we constructed length-frequency histograms for each species of trout in each section, and calculated relative weights (Blackwell et al. 2000) for all Westslope Cutthroat Trout sacrificed in each section. We also calculated proportional stock density for Westslope Cutthroat Trout in each section using minimum stock and quality lengths as 220 and 330 mm TL, respectively (Gabelhouse 1984).

Otoliths collected from WCT were prepared for microchemistry analysis at the University of Idaho. Otoliths were prepared by mounting a small cover slip (10 mm x 10 mm) to a regular microscope slide using Crystal Bond™ and then mounting the otolith to the coverslip also using Crystal Bond™. Otoliths were sanded down with varying grit sand paper until the inner primordia could be seen and mounted onto a petrographic slide for laser ablation and isotope analysis at University of California-Davis (U.C. Davis) at a later date. Methods used will be similar to Heckel et al. (2020). By comparing isotopic signatures found near the primordia of the otoliths and the isotopic signatures from analyzed water samples, we can infer which stream a fish was hatched in. This will allow us to look at relative contribution among streams in the basin to the current fishery in the mainstem Salmon River.

The assess angler effort, catch, and harvest, a creel survey was performed on the upper Salmon River from June through September 2019. These dates were chosen to coincide with the summer recreation season in Stanley, ID. We used a roving-roving design to survey the approximately 56 kilometers of river from Decker Flats and Torrey's Campground (Figure 30). Shifts were assigned randomly and covered a four-hour section of the day. Once during each shift, a count was taken by driving from Decker Flats Road to Torrey's Campground counting all anglers along the stretch. Surveys were performed on two weekdays and both weekend days every week.

To estimate angler effort, we multiplied the number of anglers counted by the summed surveyed angling hours for that day to estimate angler hours for each sampling period. That number was then divided by the proportion of the angling day in which the surveys took place. The average daily effort was then multiplied for each weekday and weekend day available for each month. Mean daily catch rate was calculated as reported catch divided by number of hours fished for each day. This was then divided across all sampling periods to give an overall catch rate for the duration of the survey. During the survey, we also asked what the target species was for each angler and we recorded angler location as the closest access site when surveyed. Overall catch was estimated by calculating the overall CPUE observed then multiplying CPUE by the proportion of each species reported caught then multiplying by total estimated effort. Harvest was not estimated because no harvest was reported by interviewed anglers.

RESULTS

In October and November, 2019, we conducted single-pass electrofishing surveys on four transects of the main stem Salmon River between Morgan Bar boat ramp and Spring Creek boat ramp. Morgan Bar-Red Rock was surveyed twice due to low catch rates of Westslope Cutthroat Trout during the first pass in October (Figure 31). Over five days, we caught a total of 319 target fish during a combined 14.0 hours of electrofishing (CPUE = 22.7 fish/h). Target species composition was 58% Westslope Cutthroat Trout, 9.7% *O. mykiss* parr (of which 100% were natural-origin), 12.2% Chinook Salmon parr (100% of which were natural-origin), 4.1% Cutthroat x Rainbow Trout hybrids, 2.8% Bull Trout, and 3.4% natural-origin *O. mykiss* > 300 mm TL (adult Rainbow Trout).

Catch rates in 2019 were highest for Westslope Cutthroat Trout in all transects (Figure 31). Mean Westslope Cutthroat Trout catch rates ranged from 5 to 24.4 fish/h, with the highest catch rate observed in the Indianola to Spring Creek transect during November (Figure 31). Catch rates ranged 0 to 1.5 fish/h for Bull Trout, 0.25 to 1.3 fish/h for natural-origin *O. mykiss* > 300 mm TL (adult Rainbow Trout), and 0.4 to 2.3 fish/h for Cutthroat x Rainbow Trout hybrids (Figure 31). Catch rates for natural-origin Chinook Salmon ranged 0 to 5.9 fish/h, and for natural-origin steelhead ranged 0.72 to 4.0 fish/h (Figure 31).

Trout size structure was similar among all transects sampled (Figure 32). Total length of Westslope Cutthroat Trout among all transects ranged from 105 to 412 mm (mean = 302 mm), and PSD ranged from 23-43 between transects (Table 17). Total length of Bull Trout among all transects ranged from 266 to 615 mm (mean = 389 mm). We did not calculate PSD for Bull Trout due to small sample sizes. Total length of *O. mykiss* > 300 mm TL (adult Rainbow Trout) among all transects ranged from 301 to 545 mm (mean = 357 mm), (Table 17). We did not calculate PSD for Rainbow Trout, since we excluded fish < 300 mm TL from this category.

In total, we collected 167 sets of otoliths from WCT for microchemistry analysis. We collected 12 in the first pass (October) of Morgan Bar to Red Rock, 19 in the second pass of Morgan Bar to Red Rock. We collected 35 sets of otoliths from Red Rock to North Fork, and 37 sets of otoliths from Deadwater to Indianola. Additionally, we collected 64 sets of otoliths from Indianola to Spring Creek (Table 18).

We captured 19 Westslope Cutthroat Trout, two Chinook Salmon parr, and two juvenile steelhead, that already contained PIT tags. When queried in PTAGIS, 17 tag histories populated for the Westslope Cutthroat Trout. From these tags, 15 of the Westslope Cutthroat Trout were tagged at the North Fork Salmon River screw trap, or during 2018 electrofishing in the mainstem Salmon River. Additionally, two Westslope Cutthroat Trout were tagged in the Lemhi drainage in July of 2019. One was tagged in Kenney Creek drainage and one in Hayden Creek. The two Chinook smolts were tagged in the Lemhi River. One at the Upper Lemhi Rotary Screw Trap on 10/14/2019 and the other at the Lower Lemhi Rotary Screw Trap on 11/11/2019. The one steelhead sampled was also tagged at the lower Lemhi Rotary Screw Trap on 11/9/2019 (Table 19). Additionally, tissue samples were collected from all 49 juvenile Chinook Salmon and were sent to the IDFG Eagle Fisheries Genetics Lab for future analysis. We deployed three PIT tags in Bull Trout during our surveys. One in the Morgan Bar-Red Rock transect, one in the Deadwater-Indianola transect and one in the Indianola-Spring Creek transect. Of these Bull Trout, two have been subsequently detected. The Bull Trout tagged in the Deadwater-Indianola transect was detected at the North Fork array on 5/23/2020, and the Bull Trout tagged in the Deadwater-Indianola transect was detected at the Taylor Ranch array at Big Creek, a tributary of the Middle Fork Salmon River on 6/21/20. These detections further highlight the importance of the Salmon River downstream of Salmon for over-wintering of not only Westslope Cutthroat Trout but Bull Trout from various areas of the Salmon River drainage.

We estimated that anglers expended 6,392 (95% C.I. ± 576) hours of angling effort from June-September. Catch per unit effort (CPUE) ranged from 0 fish/h to 0.69 fish/h with an overall estimated CPUE of 0.17 fish/h. During the survey, 41% of the effort was recorded above the Sawtooth Hatchery. “General Trout” were the target for 92% of anglers. Bull Trout were the target species for the other 8% of anglers. Estimated catch was 813 Rainbow Trout, 108 Westslope Cutthroat Trout, 101 Bull Trout, and 62 Brook Trout. No harvest was observed or reported in interviews; therefore, we could not calculate a harvest estimate. Although only accounting for 8% of total anglers, anglers targeting Bull Trout comprised 13.4% of the total effort. Furthermore, 86% of the total Bull Trout effort occurred in the Decker Flats/4th of July Creek area.

DISCUSSION

Consistent with previous year’s electrofishing events, Westslope Cutthroat Trout were the most abundant resident species of target salmonids (Messner et al. 2018, Messner et al. 2021, *in review*). The average PSD value of 33 indicates that there is a balanced population size structure present in the transects monitored in 2019. Similarly in 2016 and 2018, catch rates for suspected resident Rainbow Trout (TL ≥ 300 mm) were relatively higher in transects near the confluence with the Lemhi River, than in the downriver transects (Messner et al. 2021, *in review*). There is also a significant fluvial Rainbow Trout component that spawns in the Pahsimeroi River (Schoby 2006; Messner et al. 2021, *in review*), and main stem Salmon River electrofishing surveys conducted in 2016 between the East Fork Salmon River and North Fork Salmon River found that Rainbow Trout catch rates were highest in transects closest to the confluence with the Pahsimeroi River (Messner et al. 2017*b)*. Schoby (2006) determined that fluvial Rainbow Trout had much smaller home ranges than Bull Trout and Westslope Cutthroat Trout in the upper Salmon River basin, and caught the majority of Rainbow Trout in that study within 20 km of the mouth of the Pahsimeroi River. More information on fluvial Rainbow Trout distribution, life history, and growth is needed to help inform fisheries management of that metapopulation. We are currently working with the Pahsimeroi Fish Hatchery staff to learn more about fluvial Rainbow Trout in the Pahsimeroi River, which are trapped at the weir during steelhead trapping season. Future work should focus on identifying distinct spawning populations within, and outside of the Lemhi and Pahsimeroi rivers, and monitoring movement, describing age and growth, and monitoring abundance trends.

We only captured nine Bull Trout in 2019. We can likely attribute this difference to later sampling dates, colder water temperatures, and lower efficiencies from only using one raft electrofisher compared to two on most years. Water temperatures while sampling in November were extremely cold with water temperature readings for most days near 2° C. Schoby (2006) found that Bull Trout overwintered in pools of the Salmon River and were often sedentary during this time not leaving the pool during the winter. Our sampling gear was likely not effective in these pools where most Bull Trout would have likely been during these cold temperatures.

The anadromous parr encountered during our electrofishing surveys were exclusively natural-origin. *O. mykiss* <300mm which composed 9.7% of the catch and natural origin Chinook Salmon parr composed 12.2 % of the catch. In 2018, percent species composition was 29.2 % for *O. mykiss parr* and 14.4% Chinook Salmon parr. While the proportion of Chinook Salmon parr is similar to the 2018 sample, our proportion *O. mykiss* <300 mm is likely reduced due to our later timing of sampling. Sampling primarily occurred in October in 2018; however, with the exception of the first sampling of the Morgan Bar-Red Rock transect, all of our sampling occurred in November. Additionally, we only used one electrofishing raft during most of our sampling due to technical issues. This may have skewed the catch and any comparisons should be made with caution.

During our surveys in 2019 we recaptured several fish that had been previously PIT-tagged. The PIT-tag data from recaptured fish indicates that the section of river from Morgan Bar to Spring Creek is likely an important area for over-wintering adult Westslope Cutthroat Trout from the Lemhi River and its tributaries. Additionally, we observed Westslope Cutthroat Trout that had been tagged and detected via PIT-tag detections in the North Fork Salmon River. Our understanding of how Westslope Cutthroat Trout use the North Fork Salmon River has been increasing by using PIT-tag data. We now suspect that many fish use the North Fork Salmon River for spawning, and thermal refugia in the summer months when mainstem Salmon River temperatures become unfavorable. The North Fork Salmon River is likely a major contributor to the Westslope Cutthroat fishery from Morgan Bar to Spring Creek.

The potential information about contribution by tributary to the mainstem Salmon River fishery gained by using otolith microchemistry may be valuable however, processing of otoliths for microchemistry has proven to be expensive and time consuming for regional staff, as travel is required to Nampa, Idaho Falls, or Moscow, ID. The preparation of a single otolith is time consuming, often requiring 30-50 minutes. Additionally, to process samples and analyze hard-part chemistry they must be sent to U.C. Davis, California, or IDFG personnel must travel to U.C. Davis to process samples at a lab on campus, which is likely the more economical method. Due to this expense, in 2020 we plan to investigate the feasibility of using Genetic Stock Identification (GSI) to genetically assign fluvial Westslope Cutthroat Trout captured in the mainstem Salmon River to discreet tributaries (Hargrove et al. 2020). We believe this could be a much more economical method to evaluate fluvial Westslope Cutthroat Trout tributary production across the upper Salmon River watershed. For example, it costs approximately $77/sample to run otolith microchemistry at UC Davis, plus additional cost of preparing the sample by IDFG staff at approximately $15/sample. Additionally, it costs $245/water sample to determine baseline isotopic ratios. Our current in house costs for genetics processing and analysis is $5/sample. Furthermore, we could gain valuable information on Rainbow Trout x Westslope Cutthroat Trout introgression, genetic sex information, and genetic sampling is non-lethal.

Upper Salmon Creel Survey

The creel survey performed on the upper Salmon River in 2019 was extremely revealing in terms of angling effort. Anecdotally, effort for Bull Trout in the Decker Flats/4th of July Creek confluence area has been reported as being relatively "high" during sometimes of the year. It appears a small subset of total anglers in the upper Salmon River are targeting Bull Trout, with only 13.4% (≈830 hours) of the angling effort on the mainstem Salmon River targeting Bull Trout. However, this effort is mostly concentrated in a very small area near Decker Flats/4th of July Creek confluence. As we would expect, Rainbow Trout were estimated to be the most caught species this is likely due to our annual stocking in the upper Salmon River. We did not detect any harvest during our creel, however there is likely a low level of harvest. For example we evaluated exploitation and use of stocked Rainbow Trout in the Salmon River in 2011, 2012, and 2013. The estimate for adjusted exploitation was 12.6% and adjusted use was 19.8%, meaning that only 7.2% of fish caught were released and not reduced to possession. However, anecdotally, the Stanley area has become increasingly popular and it may be likely that many of our anglers are new to the area and may not be familiar with the regulations for harvesting Rainbow Trout, or not comfortable with their fish identification skills and choose to release fish instead of risking a citation. Furthermore, catch and release fishing continues to be extremely popular.

The angling effort in the Upper Salmon above the Sawtooth Hatchery should warrant a renewed interest in working to provide better angling opportunities in this stretch of river outside of catch and release angling for Bull Trout. Recently, there has been a renewed interest from landowners and anglers to improve fishing in this stretch of river. We should work towards projects that benefit populations of native salmonids in the upper Salmon River above the Sawtooth Hatchery. We recommend focusing management efforts on the upper Salmon River above the Sawtooth Hatchery to understand fish movement, options to address habitat, and understand factors limiting the trout populations that could that ultimately improve angling opportunities.

MANAGEMENT RECOMMENDATIONS

1. Continue annual raft electrofishing surveys to monitor fish composition, relative abundance, and size structure of salmonids in the main stem Salmon River.

2. Explore feasibility of using genetic stock identification to evaluate fluvial Westslope Cutthroat Trout tributary production across the upper Salmon River.

3. Continue to work with Pahsimeroi Hatchery staff and Lemhi IMW staff to study population dynamics of fluvial Rainbow Trout populations in the Pahsimeroi and Lemhi rivers.

4. Focus management activities on the upper Salmon River above the Sawtooth Hatchery to understand fish movement and improve angling opportunities.

Table 17. Size structure summary for Westslope Cutthroat Trout, Bull Trout, and adult Rainbow Trout captured during main stem Salmon River electrofishing surveys (October and November) in 2019. Measurements are in mm. Note: we considered only *O. mykiss* > 300 mm to be adult Rainbow Trout, therefore minimum and mean TL statistics are not displayed.

	Westslope Cutthroat Trout					Bull Trout				Adult Rainbow Trout (> 300 mm TL)	
Transect	n	Min	Mean	Max	PSD	n	Min	Mean	Max	n	Max
Morgan Bar to Red Rock	36	247	320	412	43	3	266	373	556	26	447
Red Rock to NFSR	44	155	309	380	40	3	310	421	624	10	545
Deadwater to Indianola	40	190	287	380	23	1	-	-	355	0	n/a
Indianola to Spring Creek	64	105	298	405	30	1	-	-	482	0	n/a

Table 18. Number of otoliths collected for transects surveyed by raft electrofishing in 2019.

Transect	Otoliths collected
Morgan Bar-Red Rock (October)	12
Morgan Bar-Red Rock (November)	19
Red Rock-North Fork	35
Deadwater-Indianola	37
Indianola-Spring Creek	64
Total	167

Table 19. Detection histories for Westslope Cutthroat Trout (WCT), steelhead (RBT), and Chinook Salmon (CHNK) sampled in the mainstem Salmon River in 2019. The most recent in stream array detection corresponds to the recent location column. If there is no recent location data (-), then that fish was not detected by an instream array between tagging and recapture.

Tag	Spp	Recapture date	Recapture transect	Tagged length (mm)	Date tagged	Tagging location	Recent location	Recent location date
3DD.00778C922F	WCT	11/6/2019	Red Rock-North Fork	361	9/22/2019	North Fork trap	-	-
3DD.003D2D32E3	WCT	11/6/2019	Red Rock-North Fork	344	10/10/2018	Deadwater-Indianola	-	-
3D9.1BF232ABDF	WCT	11/6/2019	Red Rock-North Fork	348	9/15/2018	North Fork trap	North Fork array	9/15/2018
3DD.003D2D32E1	WCT	11/6/2019	Red Rock-North Fork	379	10/9/2018	Red Rock-North Fork	North Fork array	9/11/2019
3D9.1BF22ED025	WCT	11/6/2019	Red Rock-North Fork	378	8/11/2019	North Fork trap	North Fork array	8/19/2019
3DD.003D7A7E35	WCT	11/6/2019	Red Rock-North Fork	375	10/1/2019	North Fork trap	North Fork array	10/1/2019
3DD.003D2D2FGE	WCT	11/6/2019	Red Rock-North Fork	319	NA	NA	-	-
3DD.003D5C8DB7	WCT	11/6/2019	Red Rock-North Fork	NA	7/24/2019	Hayden Creek	Lower Lemhi array	10/10/19
384.3B239BH1CB	WCT	11/6/2019	Red Rock-North Fork	240	NA	NA	-	-
3DD.003D2D2F3F	WCT	11/6/2019	Red Rock-North Fork	312	9/2/2019	North Fork trap	North Fork array	9/3/2019
3DD.003D2D2EDB	WCT	11/6/2019	Red Rock-North Fork	355	10/16/2018	Red Rock-North Fork	North Fork array	8/10/2019
3DD.003D2D2ED1	WCT	10/1/2019	Morgan Bar-Red Rock	412	10/17/2018	Deadwater-Indianola	North Fork array	8/28/2019
3DD.003D2D2F7E	WCT	11/13/2019	Indianola-Spring Creek	258	8/28/2019	North Fork trap	North Fork array	8/28/2019
3DD.003C007DD3	WCT	11/14/2019	Deadwater-Indianola	345	10/10/2018	Deadwater-Indianola	-	-
3DD.003C007DD0	WCT	11/14/2019	Deadwater-Indianola	322	10/10/2018	Deadwater-Indianola	-	-
3DD.003D2D2EFD	WCT	11/14/2019	Deadwater-Indianola	331	10/17/2018	Deadwater-Indianola	-	-
3DD.003D2D2FCC	WCT	11/14/2019	Deadwater-Indianola	322	10/17/2018	Deadwater-Indianola	-	-
3DD.003D2D302C	WCT	11/14/2019	Deadwater-Indianola	345	10/10/2018	Deadwater-Indianola	-	-
3DD.003D35054C	WCT	11/18/2019	Morgan Bar-Red Rock	266	7/22/2018	Kenney Creek	Lower Lemhi array	10/30/19

Table 19 (continued)

Tag	Spp	Recapture date	Recapture transect	Tagged length (mm)	Date tagged	Tagging location	Recent location	Recent location date
3DD.0077B033D9	RBT	11/18/2019	Morgan Bar-Red Rock	399	10/4/2018	Lower Lemhi trap	Lower Lemhi array	10/5/2018
3DD.0077AFB5E3	RBT	11/18/2019	Morgan Bar-Red Rock	296	9/13/2018	Lower Lemhi trap	Lower Lemhi array	9/13/2018
3DD.0077AED7A3	CHNK	11/18/2019	Morgan Bar-Red Rock	97	11/11/2019	Lower Lemhi trap	Lower Lemhi array	11/11/2019
3DD.0077B4E0C7	CHNK	11/18/2019	Morgan Bar-Red Rock	94	10/4/2019	Upper Lemhi trap	Lower Lemhi array	10/4/2019

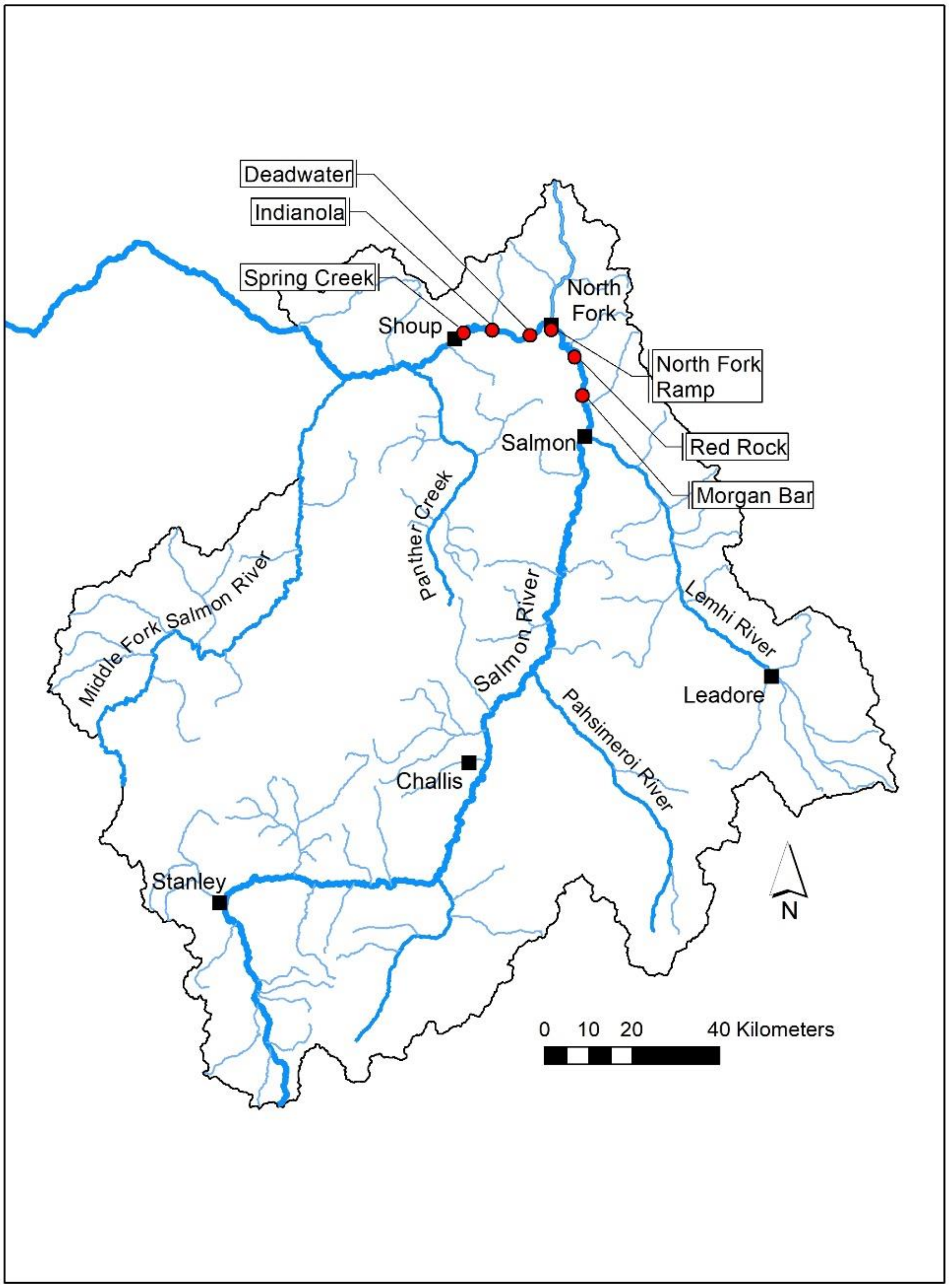

Figure 29. Approximate locations of boat ramps representing start and end points for surveys along the main stem Salmon River in 2019.

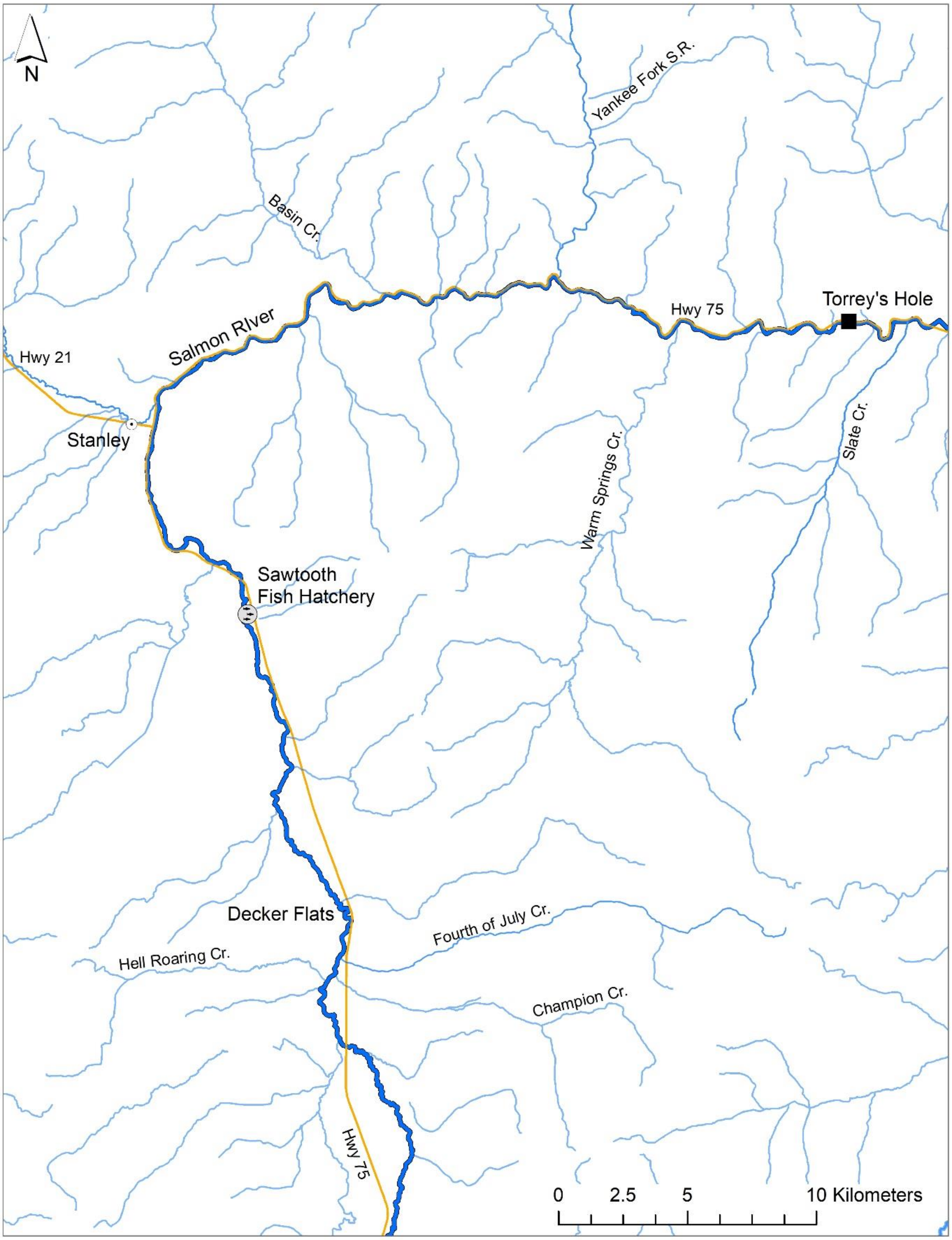

Figure 30. Map of area where upper Salmon River creel survey was performed in 2019.

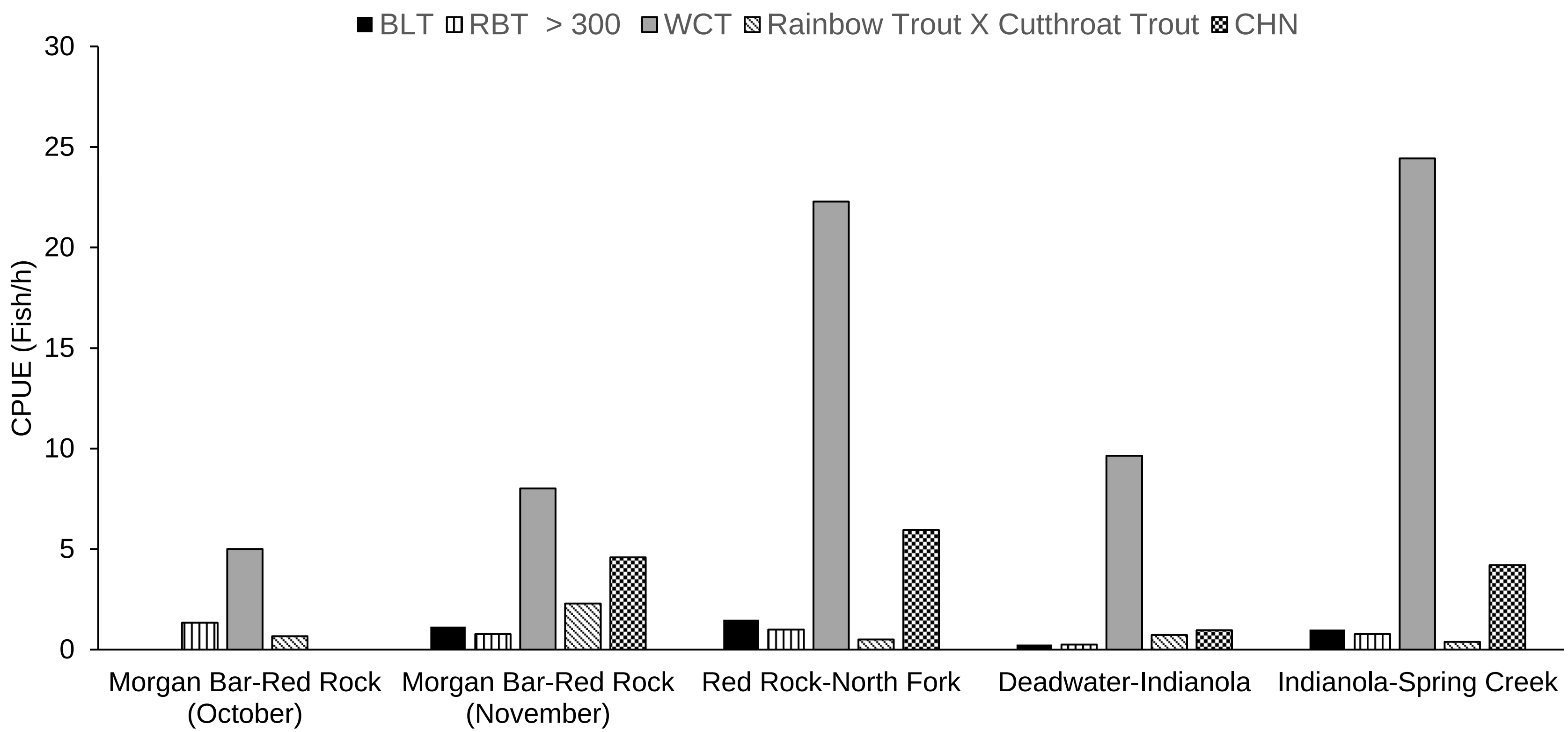

Figure 31. Catch rates (fish/h) for Bull Trout (BLT: black bars), O. mykiss > 300 mm TL (RBT > 300; adult Rainbow Trout: vertical lined bars), Westslope Cutthroat Trout (WCT: gray bars), Rainbow Trout X Cutthroat Trout hybrids (cross-hatched bars), and juvenile Chinook Salmon (CHN: checkered bars) in all 2019 transects (single pass; one e-fishing raft).

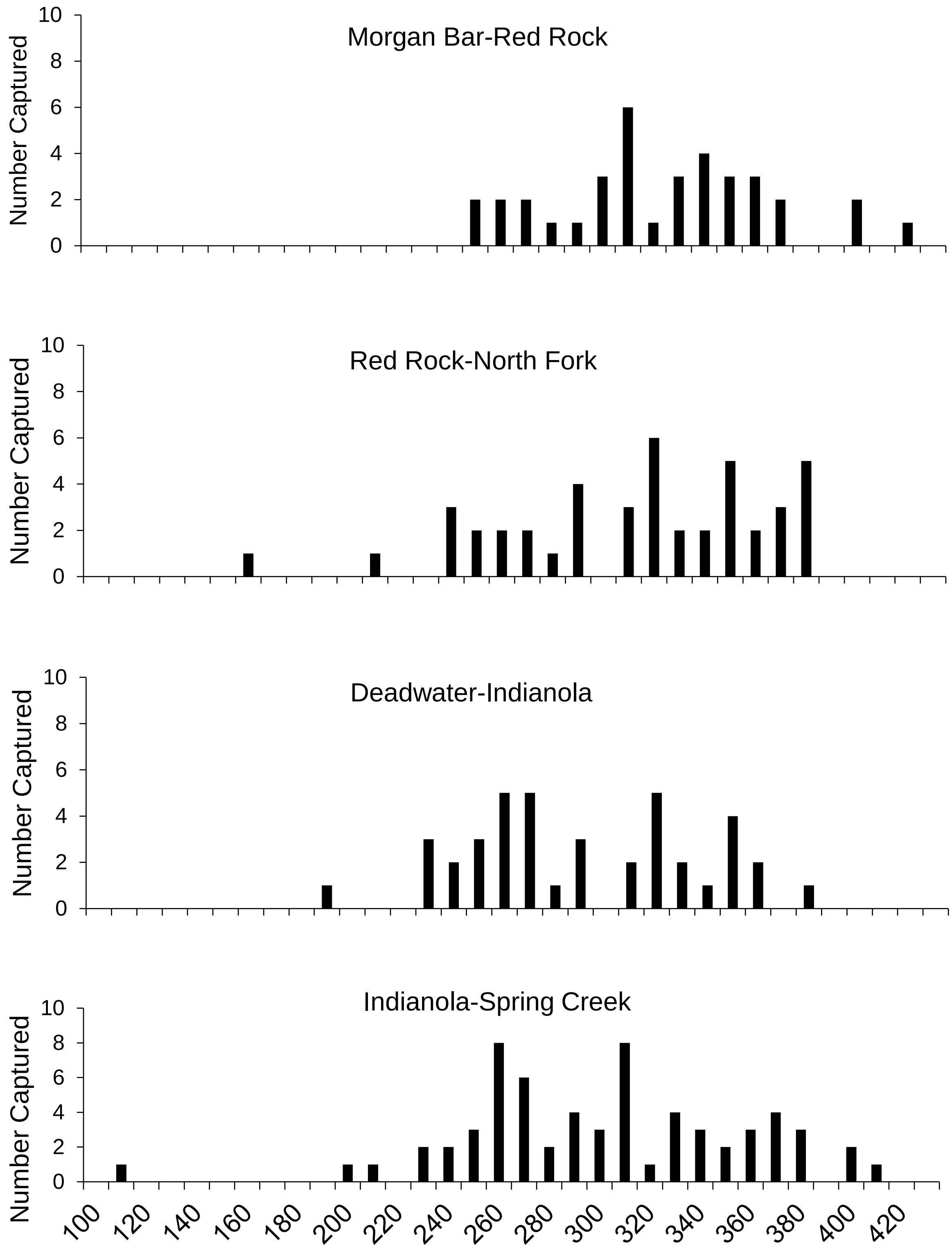

Figure 32. Westslope Cutthroat Trout relative length frequency in all main stem Salmon River transects surveyed in 2019. Transects are listed upstream to downstream (top to bottom).

NORTH FORK SALMON RIVER MOVEMENT STUDIES UPDATE

ABSTRACT

IDFG staff continued a study started in 2018 examining the movement and use of Westslope Cutthroat Trout *Oncorhynchus clarkii*, *O.mykiss*, and Bull Trout *Salvelinus confluentus* between the North Fork Salmon River, its tributaries, and the mainstem Salmon River. We re-deployed two temporary PIT-tag arrays at the same locations in 2019 as in 2018 from August 12-October 30. We also examined and summarized movement histories for Westslope Cutthroat Trout that were tagged in the mainstem Salmon River in 2018 and subsequently used the North Fork Salmon River. Additionally, using methods for monitoring anadromous emigrants, we produced an estimate of fluvial Westslope Cutthroat Trout production from the North Fork Salmon River for 2018, 2019, and 2020.

We continued to observe limited emigration of Westslope Cutthroat Trout from Hughes Creek in 2019. Additionally, we observed approximately 12.5% of the Westslope Cutthroat Trout tagged in the mainstem Salmon River in 2018 used the North Fork Salmon River from 2018-2019 with an average duration of use of 92 days. Furthermore, we produced fluvial Westslope Cutthroat Trout production estimates (± 95 % CI) of 3,003 (1,501 – 6,006), 7,439 (3,720 – 29,756), 4,141 (2,588 – 8,282) from 2018, 2019, and 2020, respectively. Management recommendations include further studying the life history, distribution, and possible entrainment issues of Westslope Cutthroat Trout within the Hughes Creek drainage, and continuing to PIT-tag all Westslope Cutthroat Trout captured at the North Fork Salmon River rotary screw trap to continue producing an annual fluvial production estimate. This estimate may be used in the future to monitor the efficacy of habitat improvement, passage improvement, irrigation screening, as well as provide a starting baseline for monitoring fluvial production from the North Fork Salmon River.

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INTRODUCTION

The upper Salmon River is well known as a Chinook Salmon *Oncorhynchus tshawytscha* and steelhead *O.mykiss* fishery, however it is under-utilized as a trout fishery. IDFG's current fisheries management plan lists "Improv[ing] the quality of trout fishing in the main stem Salmon River during the summer months" as an objective (IDFG 2018). Previous research has indicated that many of the trout in the mainstem Salmon River exhibit fluvial life histories, typically using small tributaries to spawn and rear as well as seek thermal refuge within these tributaries if temperatures in mainstem Salmon River temperatures become unfavorable (Schoby 2006). Based on this knowledge, targeting tributaries with actions that may increase production such as habitat or passage improvements may also result in a higher population of trout in the mainstem Salmon River and therefore a better overall trout fishery.

One significant tributary that has potential for improvement is the North Fork Salmon River (hereafter referred to as "the North Fork"). At 56 kilometers in length, the North Fork is known to be an important spawning tributary for Chinook Salmon and steelhead. Until recently, the North Fork was given very little consideration for management or restoration actions although several tributaries within the North Fork drainage and the North Fork proper were historically stocked with steelhead and Westslope Cutthroat Trout (WCT) *O. clarkii*, likely in response to anthropogenic habitat alterations and low anadromous returns (IDFG stocking database). However, even though it has been stocked and resident and fluvial forms of WCT and Bull Trout (BT) *S. confluentus* are known to exist, very little is understood about the composition, abundance, size structure, or life history of these species that are present in the drainage (Schoby 2006; Messner et al. 2017).

Recently installed infrastructure in the North Fork has allowed us to better understand the life histories and movement of resident salmonids that use the North Fork as well as the mainstem Salmon River. A permanent Passive Integrated Transponder (PIT) instream array (North Fork array) and a rotary screw trap (RST) were installed in the North Fork in 2015 to primarily monitor production of anadromous salmonids in the watershed. However, this infrastructure has been leveraged to help provide information on resident fish use in the North Fork (i.e. WCT and BT) by having staff PIT-tag resident fish captured at the North Fork RST and monitoring immigration and emigration via the North Fork array. Additionally, a watershed-wide movement and species composition study using PIT-tagging was completed in 2018 in order to understand which tributaries may have a fluvial BT population, WCT population and/or a steelhead/*O.mykiss* population within the watershed. Study design and results of the 2018 effort can be found in Messner et al. (2021; *in review*). We continued this study in 2019 with the re-installation of two temporary PIT tag arrays. These PIT tag arrays were set up in the exact same locations as in 2018. One was placed in the North Fork, immediately below the mouth of Sheep Creek (herafter referred to as "Sheep Cr. array") and the other was placed in Hughes Creek near the mouth of Hughes Creek (hereafter referred to as "Hughes Cr. Array") (Figure 33). Additionally we used the North Fork RST to produce estimates of fluvial emigration of WCT into the mainstem Salmon River. The objectives of this ongoing study are to provide an overview of our current knowledge of resident fish use of the North Fork Salmon River and to understand fluvial WCT production and tributary specific contribution to the fluvial trout fisheries of the mainstem Salmon River. This understanding of tributary specific contribution will allow us to target tributaries for future habitat projects or other projects that may increase fluvial trout production and therefore lead to a more desirable angling experience in the mainstem Salmon River as outlined in the IDFG Fisheries Management Plan.

OBJECTIVES

1. Provide an overview of our current knowledge of resident fish use of the North Fork Salmon River.
2. Understand baseline fluvial Westslope Cutthroat Trout production and tributary specific contribution to the resident and fluvial fisheries of the mainstem Salmon River in an effort to target tributaries for future habitat projects or other projects that may increase fluvial trout production.

STUDY AREA

The North Fork Salmon River is a tributary of the Salmon River, with its confluence flowing through the town of North Fork, Idaho approximately 34 km north of Salmon, Idaho, Lemhi County. The watershed drains southward out of the Beaverhead Mountain Range with elevations ranging from 2,175 m near Lost Trail Pass on the border of Idaho and Montana to 1,102 m at its confluence with the Salmon River (Figure 33). A paved, two-lane road (Route 93) follows the river from its confluence with the Salmon River upstream to its headwaters near Lost Trail Pass, and dirt roads follow most of its major tributaries upstream into National Forest land. Parts of the watershed were altered by mining in the early to mid-1900s, and both the timber and agriculture industry are evident today in some areas. Property ownership of the watershed is mixed, with predominately private ownership in the lower elevation river corridor and valley bottoms, with federal ownership in the uplands. Hughes Creek flows from the western side of the North Fork drainage. It has historically been impacted by dredge mining, grazing, and unscreened irrigation diversions. Sheep Creek just south of Gibbonsville, Idaho and drains the eastern side of the North Fork drainage with its origins near the Idaho/Montana border. Similar to Hughes Creek, it has also been anthropogenically impacted but to a much lesser extent. Lands in both Hughes Creek and Sheep Creek are privately owned near their confluence with the North Fork Salmon River but quickly transition into federally owned land moving up each drainage.

METHODS

In 2018, a drainage-wide electrofishing survey was conducted. A total of 33 transects were sampled within the North Fork Salmon River watershed (Figure 33). Information on these sites and results of fish presence, composition, and relative abundance from this survey can also be found in Messner et al. (2021) *in review.* During the 2018 survey of the North Fork Salmon River and tributaries, 880 PIT tags were deployed throughout the watershed. Of the 880 tags, 265 were deployed in 4 tributaries to evaluate the presence of fluvial production of Bull Trout and Westslope Cutthroat Trout in the North Fork Salmon River. In 2018, emigration of Westslope Cutthroat Trout was documented out of all tributaries they were tagged with the exception of Hughes Creek (incl. Ditch Creek). Additionally, no emigration of WCT tagged in 2018 was observed while the Hughes Cr. Array and Sheep Cr. Array were not in place between winter 2018 and August 2019. However, 82 *O.mykiss* tagged during the surveys in 2018 were observed emigrating from the North Fork to the mainstem Salmon River via the North Fork array during this time including seven from Hughes Cr. and one from Sheep Creek. All other *O.mykiss* emigrants observed at the North Fork array during this time were tagged in the mainstem North Fork. Additionally, we believe that it may take several years of rearing before WCT emigrate from tributaries into the North Fork. This is based upon average lengths observed during tagging within tributaries of the North Fork and mainstem North Fork Salmon River and size at capture of WCT at the North Fork RST (Messner et al. 2021; *in review*). For example, the mean total length (mm) for WCT tagged in Hughes Creek in 2018 was 105.6 mm and ranged from 38 to 204 mm, and the mean total length of WCT captured in the mainstem North Fork was 237.3 mm with a range from 53 to 390 mm (Messner et al. 2021; *in review*). Based upon these examples and the likelihood that we would continue to see outmigration from WCT tagged in 2018, we again deployed temporary PIT tag arrays immediately below Sheep Creek and on Hughes Creek from August 12th to October 30th, 2019, to monitor possible outmigration of WCT, *O.mykiss*, and BT.

Tag detection efficiency at each array was calculated using the following formula:

$$E_{ARRAY1} = \frac{(T_{COMMON\ TO\ ARRAYS\ 1+2})}{(T_{UNIQUE\ TO\ ARRAY\ 2} + T_{COMMON\ TO\ ARRAYS\ 1+2})}$$

where E is calculated efficiency and T is the number of tags detected.

Additionally, we summarized tag histories of WCT tagged in the mainstem Salmon River during electrofishing surveys that were subsequently detected at the North Fork array from 2018-2019 to examine use of the North Fork by these individuals. This included calculation of average immigration date, average emigration date, and duration of use of the North Fork. Individuals that were only detected immigrating were not included in the calculation of duration of use. This tagging event occurred during electrofishing surveys in 2018 surveys when 912 individual WCT were tagged in the mainstem from Morgan Bar downstream to Copper Mine (Figure 34). Tag histories were queried from PTAGIS (ptagis.org).

We also calculated the first estimate of fluvial WCT production for the North Fork using data collected at the RST. Data collected from 2018-2020 indicate that the majority of emigration by WCT from the North Fork occurs annually between August 1 and November 30. To ensure against biasing our estimate via size selectivity of the RST, we examined size structure of WCT caught at the RST compared to the size structure of *O.mykiss* captured at the RST as well as the size structure of WCT sampled at mainstem North Fork electrofishing sites in 2018 (Figure 35; Messner et al. 2021; *in review*). Based on this data, we concluded that there did not appear to be a size selectivity bias at the trap and it likely represented the actual size structure of emigrating WCT in the North Fork, at least when compared to our best known size structure data for WCT in the mainstem of the North Fork. Additionally, after examining the size structure data we established a maximum length cutoff of 280 mm for a WCT to be counted as a first time emigrant to the mainstem Salmon River. It is likely that fish longer than 280 mm are returning adults and are captured after spawning or seeking thermal refuge when returning to the mainstem Salmon River. We then followed the methods outlined in Copeland et al. (2021) to produce an emigrant estimate with a bootstrapping method consisting of 10,000 iterations to produce 95% confidence intervals (Copeland et al. 2021; IDFG IFWIS Shiny apps). We did extend the recapture timing to 10 days instead of 5 as used emigrant production calculations to allow for more recaptures to be included in our estimates.

RESULTS

Both the Sheep Cr. Array and Hughes Cr. array operated from August 12th until October 30th 2019. Similar to 2018, we continued to observe very little *O. mykiss* and no WCT emigration from Hughes Creek array in 2019 (Table 20). During our 2019 deployment we detected two *O. mykiss* at the Hughes Cr. array that were tagged in 2018. At the Sheep Creek array we detected two WCT and two BT that were tagged in Sheep Creek in 2018. We also detected 12 adult WCT at the Sheep Cr. array during operations in 2019 (Table 21). These 12 adult WCT were tagged in previous raft electrofishing events in the mainstem Salmon River from Red Rock downstream to Indianola (Figure 34). Efficiency of both the Hughes Cr. array and Sheep Cr. array was not calculated due to low sample size.

At the North Fork array, a total of five WCT were detected emigrating from Sheep Creek from 2018-2020 (Table 22). One was detected in August 2018, two in September 2018, one in September 2019, and one in September 2020. Two WCT tagged in Twin Creek in 2018 were also detected emigrating in August of 2019 (Table 22). None of the WCT tagged in Hughes Cr in 2018 were detected in 2019. Furthermore, only one WCT tagged in Hughes Creek has been detected at the North Fork array. This detection occurred in August of 2020. Thirty-one additional WCT were detected emigrating at the North Fork array from 2018-2020 that were tagged at mainstem North Fork sites in 2018 (Table 22).

Ten total *O*. *mykiss* tagged in Hughes Creek have been detected at the North Fork array from 2018-2020 (Appendix A). *O. mykiss* were also observed emigrating from the upper mainstem North Fork, including Dahlonega Creek (Appendix A). *O. mykiss* appear to primarily emigrate in the spring and fall.

A total of 10 BT tagged in 2018 were observed at the North Fork Array in 2018 and 2019. Four were tagged at the Murphy Property, five were tagged in Sheep Creek, and one from Twin Creek. Emigration for BT passing the North Fork array occurred in February, May, June, September, October, and November (Table 23).

Westslope Cutthroat Trout tagged during the 2018 mainstem electrofishing surveys exhibited various strategies for using of the North Fork Salmon River. Average total length (TL ± SE) of WCT that used the North Fork was 327.5 mm (± 3.6) at capture in 2018. The North Fork was subsequently used by 114 of 912 (12.5%) individually tagged WCT in 2019. Average duration of use was 92 days (max = 178 days) with an average date of immigration of 5/10/2019 and an average date of emigration of 7/1/2019. The vast majority of individuals using the North Fork Salmon River were tagged in the Red Rock-North Fork transect of the mainstem Salmon River. Several individuals were only observed immigrating into the North Fork and not detected emigrating. These individuals were only observed one time on the North Fork array and may have been missed when emigrating later or were mortalities while in the North Fork, they may also have just passed gotten near enough to the array be detected and then resided downstream of the array. Due to this they were not included in the duration calculation (Appendix B). Immigrations occurred from April to July. April was the highest month for immigrations with 54 individual WCT immigrating to the North Fork from the mainstem Salmon River. June was the lowest with 5 individuals immigrating (Figure 36). The latest date of emigration back to the mainstem Salmon River was 10/26/2019 with an average date of emigration of 8/13/2019. By month, the highest emigration occurred in September with 24 individuals emigrating to the mainstem Salmon River. October had the least amount of emigrations with only three individuals emigrating (Figure 37). Movement history for these individuals can be found in Appendix A.

From 2018 to 2020, we captured, PIT-tagged, and released 558 individual WCT at the North Fork Salmon River RST. Average total length (± SE) was 238.9 mm (± 1.9). After instituting our 280-mm maximum total length cutoff, we produced estimates for fluvial production for 2018, 2019, and 2020 with 95% confidence intervals corresponding to brood years 2015, 2016, and 2017, respectively. This assumes that emigrant WCT are on average three years of age, however it is simply a place holder for calculations and it is likely that two and three year old WCT are emigrating. In 2018, we captured and tagged 77 WCT and had 1 recapture. In 2019, we captured 172 individuals and had 3 recaptures. In 2020, we captured 203 individuals and had 9 recaptures (Table 24). Trap efficiencies for 2018, 2019, and 2020 were 1.3%, 1.7% and 4.4%, respectively. Our 2018 (brood year 2015) estimate for WCT emigration from the North Fork to the mainstem Salmon River was 3,003 (1,501 – 6,006) WCT. Our estimate for 2019 (brood year 2016) was 7,439 (3,720 – 29,756) WCT and our estimate for 2020 (brood year 2017) was 4,141 (2,588 – 8,282) WCT (Table 25).

DISCUSSION

Our results from monitoring of emigration from tributaries in 2018 and 2019 indicates that all surveyed tributaries from 2018 are likely contributing to resident populations of WCT in the North Fork Salmon River and tributaries of the North Fork as well as fluvial populations in the mainstem Salmon River. The continued lack of fluvial WCT contribution from Hughes Creek is interesting since Ditch Creek, a tributary of Hughes Creek, had the highest densities of WCT during the 2018 surveys (Messner et al. 2021; *in review*). The lack of fluvial life history may be due to entrainment at nine unscreened irrigation diversions in Hughes Creek. Future research should focus closer on specific tributaries and finding possible limiting factors within them such as lack of suitable habitat or possible entrainment issues. To start, we recommend a study focused on Hughes Creek to understand the life histories and possible entrainment issues for WCT and *O.mykiss* contributions to the North Fork and mainstem Salmon River.

Monitoring the use of the North Fork Salmon River by WCT tagged in the mainstem Salmon River in 2018 indicates that a significant portion of WCT from mainstem Salmon River continue to use the North Fork for spawning and/or thermal refugia. This was also indicated by Schoby (2006). The mainstem Salmon River downstream of the town of Salmon often experiences high temperatures during the summer months (Brent Beller IDFG-unpublished data). The timing of immigration and emigration into and out of the North Fork highlight the importance of cold water refugia to the WCT population in the mainstem Salmon River near the North Fork.

The North Fork also appears to be an important spawning and rearing tributary for BT. According to Messner et al. (*in review*)*,* BT are primarily found in the mainstem North Fork and Sheep Creek. Emigration of BT into the mainstem Salmon River has primarily occurred in June likely during spring run-off, however it appears that BT will also emigrate in the fall and winter.

The estimates calculated from the RST for fluvial production should be viewed with some caution since the trap efficiencies are low, especially during 2018 when only PIT-tagged WCT was recaptured. However, this data could be extremely useful in evaluating the overall effect of future habitat restoration actions, irrigation screening, and further developing methods to monitor specific tributary contribution to the fluvial WCT population in the mainstem Salmon River. When compared to steelhead production estimates from the North Fork during the summer/fall of the same years, the point estimate for WCT production is very similar in 2018 and actually slightly higher than steelhead in 2019. For example, summer/fall production estimate for steelhead >80 mm in fork length was 3,841 in 2018, 6,691 in 2019, and 2,762 in 2020, compared to 3,003 and 7,439, and 4,141 WCT, respectively (Poole et al. 2019; Feeken et al. 2020, McClure et al. 2021). Additional refining of this method is likely needed. We recommend to continue tagging all resident salmonids encountered at the North Fork RST for the foreseeable future and will continue to refine these methods. Timing of emigration of untagged WCT from the North Fork and WCT tagged in the mainstem North Fork appears to be synchronous. Unsurprisingly, it is likely advantageous to overwinter in the bigger and slower mainstem Salmon River as compared to the colder and higher gradient North Fork Salmon River. This is also similar to what Schoby et al. (2006) found when radio-tagged WCT were noted moving downstream and out of tributaries to the larger holes in the mainstem Salmon River in preparation for over-wintering.

MANAGEMENT RECOMMENDATIONS

1. Design and implement a study to understand the life histories and possible entrainment issues for Westslope Cutthroat Trout and *O.mykiss* in the Hughes Creek drainage.

2. Continue tagging of all Westslope Cutthroat Trout captured at the North Fork rotary screw trap to continue producing annual fluvial production estimates for Westslope Cutthroat Trout emigrating from the North Fork Salmon River.

Table 20. Tag number, observation date, species, length, date tagged, and tag location of PIT-tag detections at the Hughes Creek array in 2019.

Tag	Obs. Date	Species	Length (mm)	Date tagged	Tag location
3DD.003D2C51F7	9/30/2019	*O.mykiss*	176	8/12/2018	MURPHY PROPERTY
3DD.003D2D31A3	10/5/2019	*O.mykiss*	99	7/10/2018	HUGHES CR-SNFHC-02
3DD.003D2D3245	10/7/2019	*O.mykiss*	119	7/10/2018	HUGHES CR-SNFHC-05

Table 21. Tag, observation date (Obs. Date), species (Spp.), length, date tagged, and tag location for tags detected at the Sheep Creek PIT-tag array in 2019.

Tag	Obs. date	Spp.	Length (mm)	Date tagged	Tag location
3DD.003D2C4FE5	10/5/2019	BT	145	7/9/2018	Sheep Creek - SNFSC-06
3DD.003D2D2EF1	9/15/2019	BT	390	10/16/2018	Salmon R - Red Rock-North Fork
3DD.003D2D2F99	9/29/2019	BT	274	10/17/2018	Salmon R - Deadwater-Indianola
3DD.003D2D2FDB	8/30/2019	BT	498	10/16/2018	Salmon R - Red Rock-North Fork
3DD.003D2D30FB	9/17/2019	BT	345	8/15/2018	Sheep Creek - SNFSC-02
3DD.003D2D3160	9/14/2019	BT	346	8/12/2018	NFSR - Murphy Property
3DD.003C007D4C	9/7/2019	WCT	296	4/24/2018	Salmon R - Bobcat to Deadwater
3DD.003C007D58	9/6/2019	WCT	327	4/22/2018	Salmon R - 4th of July-NFSR
3DD.003C007E19	9/12/2019	WCT	331	10/9/2018	Salmon R - Red Rock-North Fork
3DD.003C007E25	9/20/2019	WCT	330	10/9/2018	Salmon R - Red Rock-North Fork
3DD.003D2C4FEA	9/22/2019	WCT	184	7/9/2018	Sheep Creek - SNFSC-04
3DD.003D2D2EFB	9/25/2019	WCT	350	10/16/2018	Salmon R - Red Rock-North Fork
3DD.003D2D2F00	8/22/2019	WCT	365	10/17/2018	Salmon R - Deadwater-Indianola
3DD.003D2D2F1E	9/10/2019	WCT	300	10/16/2018	Salmon R - Red Rock-North Fork
3DD.003D2D2F9E	9/10/2019	WCT	285	10/16/2018	Salmon R - Red Rock-North Fork

Table 21 (continued)

Tag	Obs. date	Spp.	Length (mm)	Date tagged	Tag location
3DD.003D2D30C5	9/20/2019	WCT	305	10/9/2018	Salmon R - Red Rock-North Fork
3DD.003D2D322F	9/1/2019	WCT	320	10/16/2018	Salmon R - Red Rock-North Fork
3DD.003D2D32CF	9/9/2019	WCT	286	10/9/2018	Salmon R - Red Rock-North Fork
3DD.00778CCFC0	8/26/2019	WCT	278	4/24/2018	Salmon R - Bobcat-Deadwater
3DD.003D2C4E83	10/10/2019	*O.mykiss*	100	8/13/2018	NFSR - Phil treatment
3DD.003D2C4ED4	10/4/2019	*O.mykiss*	112	8/13/2018	NFSR - Phil treatment
3DD.003D2C4EE6	9/24/2019	*O.mykiss*	122	7/11/2018	NFSR - SNF-08
3DD.003D2C4F32	10/30/2019	*O.mykiss*	171	8/12/2018	NFSR - Thomas control
3DD.003D2C4F7A	10/4/2019	*O.mykiss*	130	8/15/2018	NFSR - Phil treatment
3DD.003D2D318C	10/6/2019	*O.mykiss*	92	7/8/2018	NFSR - Phil treatment

Table 22. Tag number, observation date (Obs. date), length, date tagged, and tag location for Westslope Cutthroat Trout tagged in the North Fork in 2018 and detected emigrating at the North Fork array from 2018-2020.

Tag	Obs. date	Length (mm)	Date tagged	Tag location
3DD.003D2D312B	4/18/2019	370	8/12/2018	NFSR - Boyne Property
3DD.003D2D3176	9/27/2018	351	8/12/2018	NFSR - Boyne Property
3DD.003C007E57	8/12/2020	102	6/25/2018	Hughes Creek - SNFHCSC
3DD.003D2C4FCB	9/15/2018	202	7/8/2018	NFSR - Phil treatment
3DD.003D2C4FDE	9/28/2018	327	7/8/2018	NFSR - Phil treatment
3DD.003D2D30D8	9/15/2018	209	8/13/2018	NFSR - Phil treatment
3DD.003D2D30F8	7/15/2019	245	8/13/2018	NFSR - Phil treatment
3DD.003D2D3118	9/7/2018	224	8/15/2018	NFSR - Phil treatment
3DD.003D2D3170	9/8/2018	189	8/15/2018	NFSR - Phil treatment
3DD.003D2D3135	9/27/2018	195	7/11/2018	NFSR - SNF-08
3DD.003D2D3197	7/25/2019	125	7/2/2018	NFSR - SNF-09
3DD.003D2D3250	10/9/2019	126	7/2/2018	NFSR - SNF-09
3DD.003D2D3156	10/5/2018	163	7/11/2018	NFSR - SNF-10A
3DD.003D2D312F	10/4/2018	198	7/11/2018	NFSR - SNF-10B
3DD.003D2D3158	9/16/2018	197	7/11/2018	NFSR - SNF-10B
3DD.003D2D3159	11/2/2018	345	8/15/2018	NFSR - Thomas control
3DD.003D2D3162	9/19/2018	334	8/12/2018	NFSR - Thomas control
3DD.003D2D313D	9/9/2018	269	8/12/2018	NFSR - Thomas control
3DD.003D2D3166	9/18/2018	248	8/12/2018	NFSR - Thomas control
3DD.003D2D314D	9/14/2018	215	8/12/2018	NFSR - Murphy Property
3DD.003D2D3167	9/18/2018	262	8/12/2018	NFSR - Murphy Property
3DD.003D2D3179	8/31/2018	330	8/12/2018	NFSR - Murphy Property
3DD.003D2D317C	8/31/2018	256	8/12/2018	NFSR - Murphy Property
3DD.003D2D30C8	4/28/2019	345	8/13/2018	NFSR - Murphy Property
3DD.003D2D30D2	9/13/2018	372	8/13/2018	NFSR - Murphy Property
3DD.003D2D30F0	4/24/2019	150	8/13/2018	NFSR - Murphy Property
3DD.003D2D30F7	4/20/2019	358	8/13/2018	NFSR - Murphy Property
3DD.003D2D30FE	9/12/2018	274	8/13/2018	NFSR - Murphy Property
3DD.003D2D310E	9/12/2018	261	8/13/2018	NFSR - Murphy Property
3DD.003D2D3110	9/18/2018	237	8/13/2018	NFSR - Murphy Property
3DD.003D2D314C	9/16/2018	252	8/13/2018	NFSR - Murphy Property
3DD.003D2D30F4	8/31/2018	225	8/15/2018	Sheep Creek - SNFSC-02
3DD.003D2D3104	9/19/2020	121	8/15/2018	Sheep Creek - SNFSC-02
3DD.003D2D3111	9/12/2018	185	8/15/2018	Sheep Creek - SNFSC-02

Table 22 (continued)

Tag	Obs. date	Length (mm)	Date tagged	Tag location
3DD.003D2C4FC4	9/11/2018	237	7/9/2018	Sheep Creek - SNFSC-04
3DD.003D2C4FEA	9/29/2019	184	7/9/2018	Sheep Creek - SNFSC-04
3DD.003D2D324C	8/13/2019	175	7/2/2018	Twin Creek - SNFTC-01
3DD.003D2D32A2	8/9/2019	199	7/2/2018	Twin Creek - SNFTC-01

Table 23. Tag number, observation date (Obs. date, length, date tagged, and tag location for Bull Trout tagged in the North Fork in 2018 and detected at the North Fork array from 2018-2020.

Tag	Obs. date	Length (mm)	Tag date	Tag location
3DD.003D2D30E5	9/10/2018	338	8/13/2018	NFSR - Murphy Property
3DD.003D2D30ED	2/17/2019	236	8/13/2018	NFSR - Murphy Property
3DD.003D2D30F6	9/19/2018	367	8/13/2018	NFSR - Murphy Property
3DD.003D2D3160	9/13/2018	342	8/12/2018	NFSR - Murphy Property
3DD.003D2C4FA7	5/30/2019	196	7/8/2018	Sheep Creek - SNFSC-02
3DD.003D2D30FB	11/20/2019	345	8/15/2018	Sheep Creek - SNFSC-02
3DD.003D2C4FA8	6/20/2019	161	7/8/2018	Sheep Creek - SNFSC-03
3DD.003D2C4FBB	6/11/2019	200	7/8/2018	Sheep Creek - SNFSC-03
3DD.003D2C4FE5	10/13/2019	145	7/9/2018	Sheep Creek - SNFSC-06
3DD.003D2D31B3	9/9/2018	193	7/2/2018	Twin Creek - SNFTC-01

Table 24. Inputs for fluvial production mark-recapture model for brood years 2015-2017 for Westslope Cutthroat Trout captured in the North Fork Salmon River rotary screw trap. C = number captured, M=number marked and released, R=number recaptured.

Trap	Brood year	Life stage	Strata	C	M	R
NFSR	2015	Juvenile	Fall	77	77	1
NFSR	2016	Juvenile	Fall	172	172	3
NFSR	2017	Juvenile	Fall	203	203	9

Table 25. Results of fluvial production of Westslope Cutthroat Trout for brood years 2015-2017 including 95% confidence intervals.

Trapping year	Brood year	Estimate	Lower 95% CI	Upper 95% CI
2018	2015	3,003	1,502	6,006
2019	2016	7,439	3,720	29,756
2020	2017	4,141	2,588	8,282

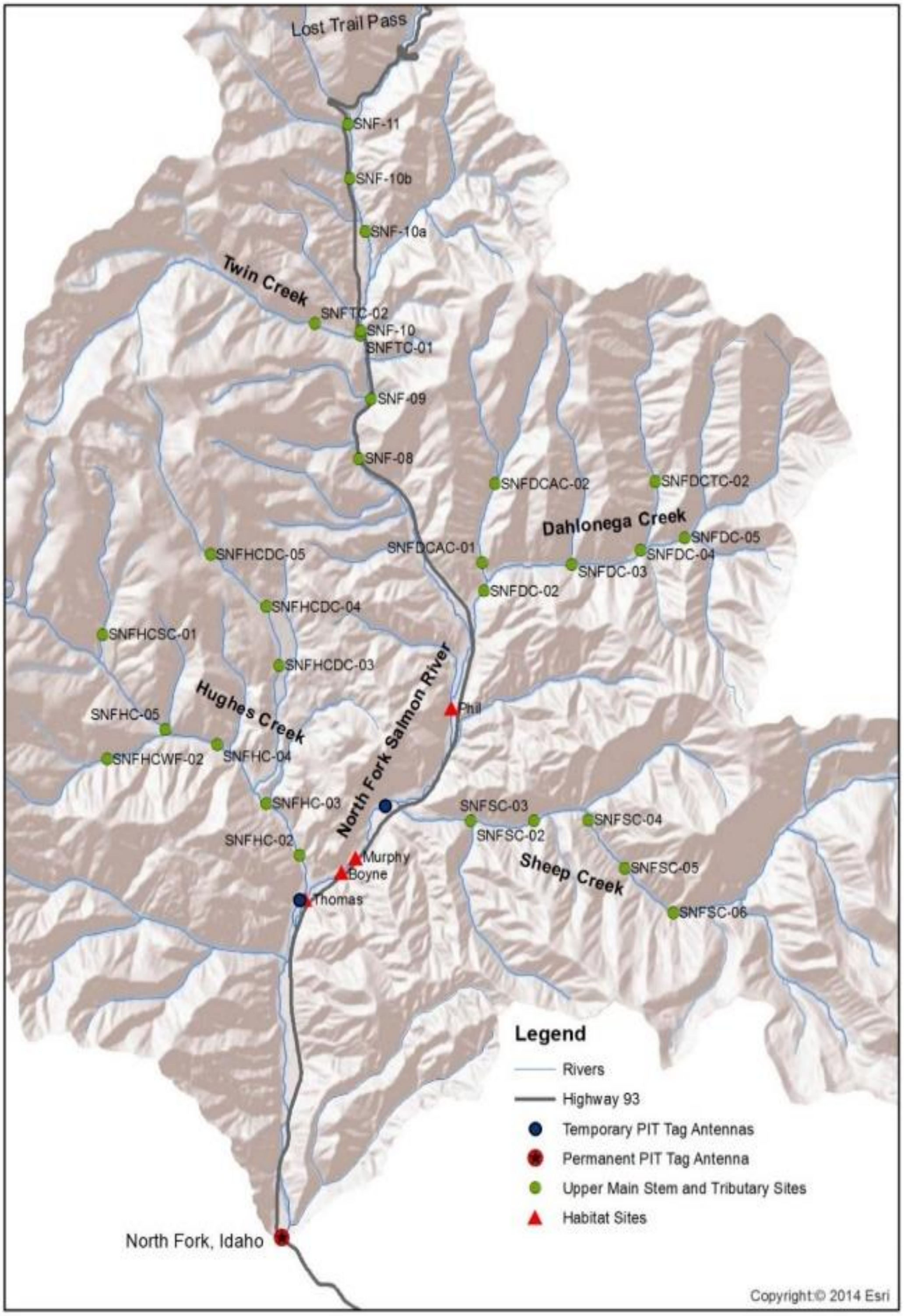

Figure 33. Map of the North Fork Salmon River watershed, showing sites surveyed in 2018 and locations of PIT arrays in 2018 and 2019.

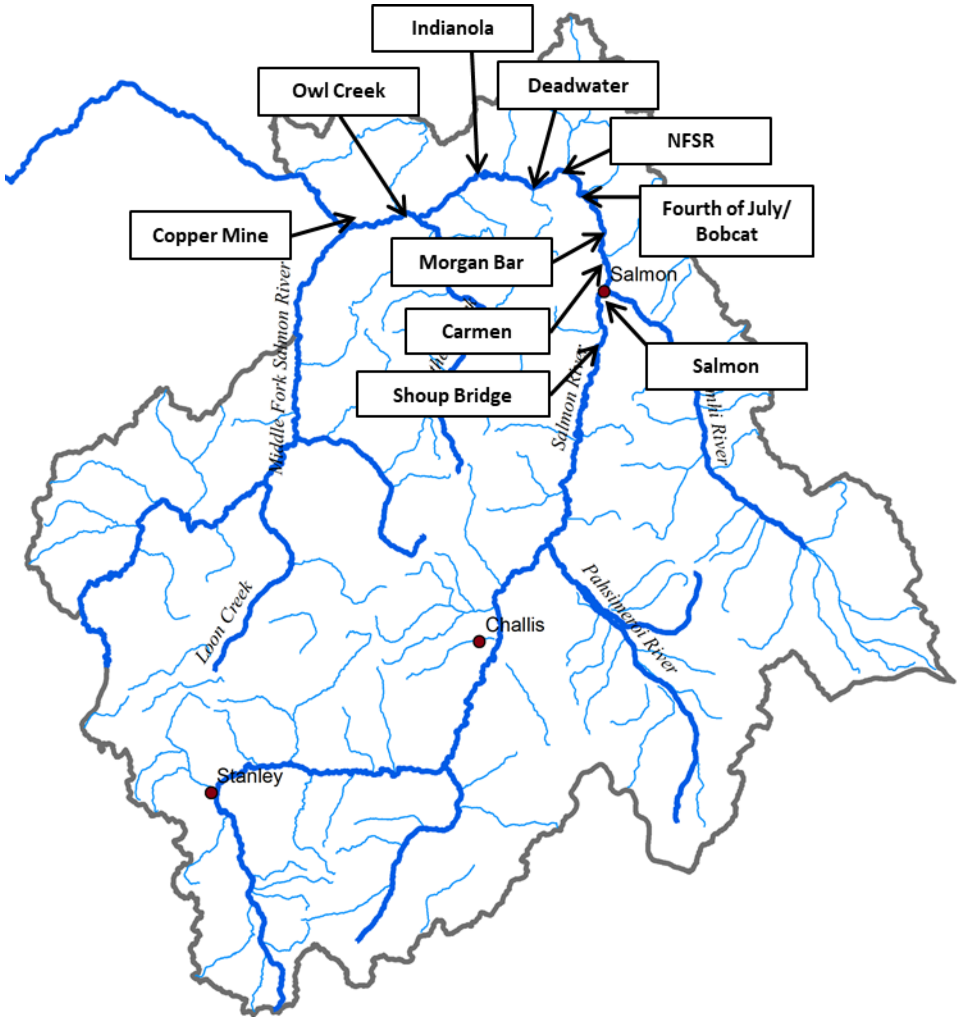

Figure 34. Approximate locations of boat ramps representing start and end points of surveys along the main stem Salmon River in 2018.

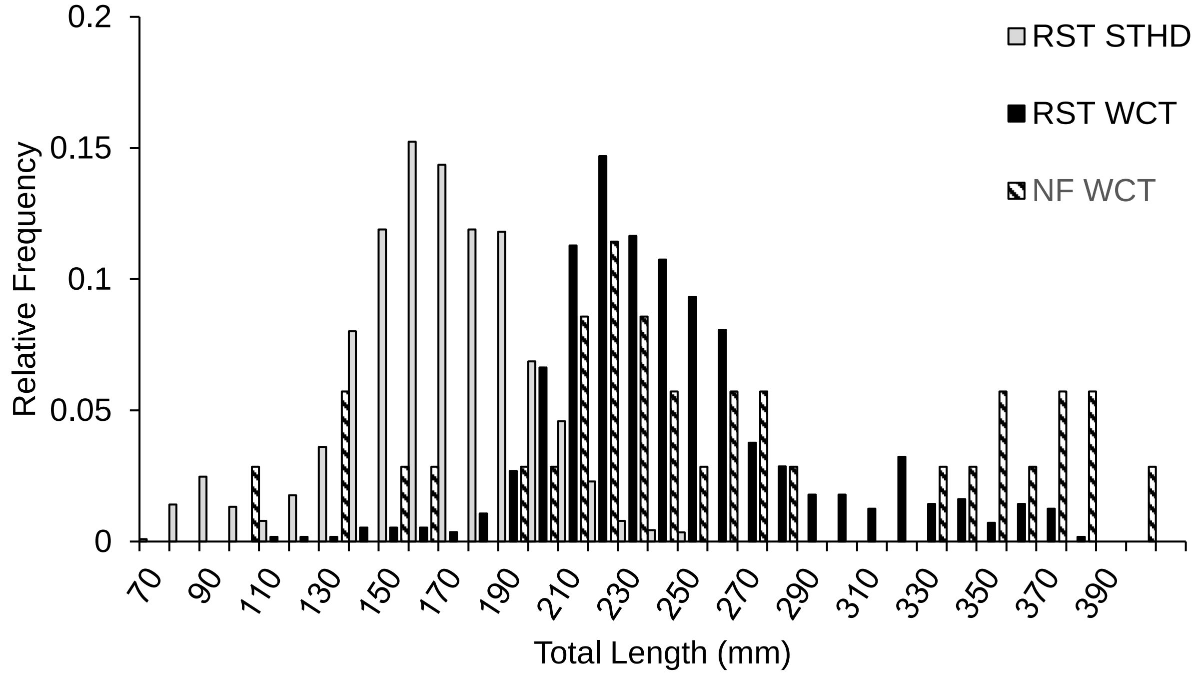

Figure 35. Relative frequency of steelhead (RST STHD; gray bars) and Westslope Cutthroat Trout (RST WCT; black bars) captured at the North Fork rotary screw trap, and Westslope Cutthroat sampled in the mainstem North Fork Salmon River (NF WCT; cross hatched bars).

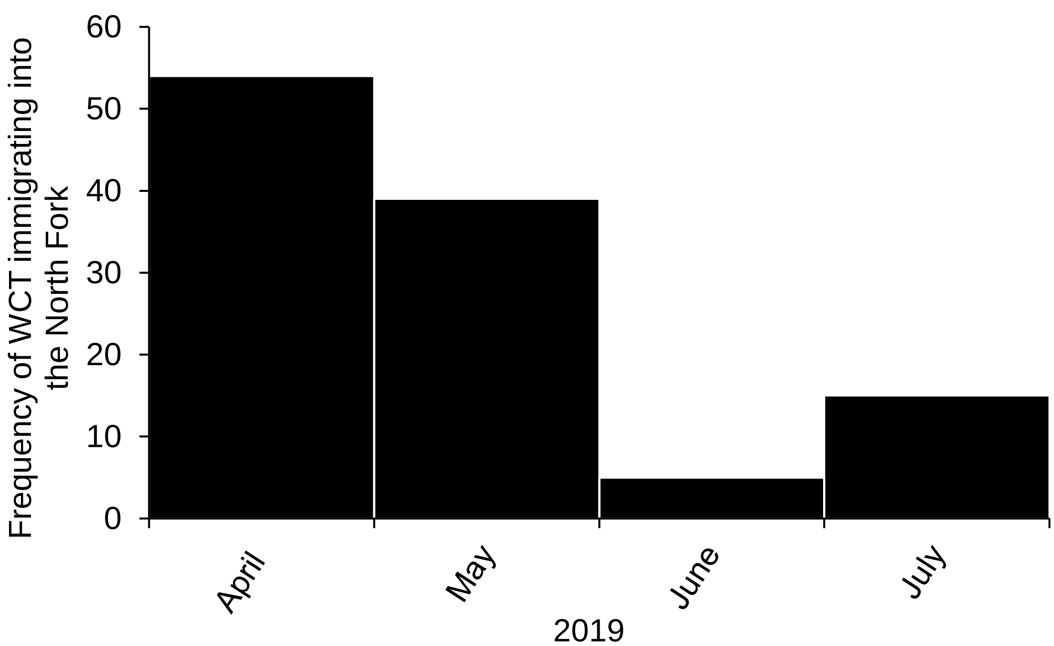

Figure 36. Frequency by month for Westslope Cutthroat Trout (WCT) tagged in the mainstem Salmon River immigrating to the North Fork Salmon River in 2019.

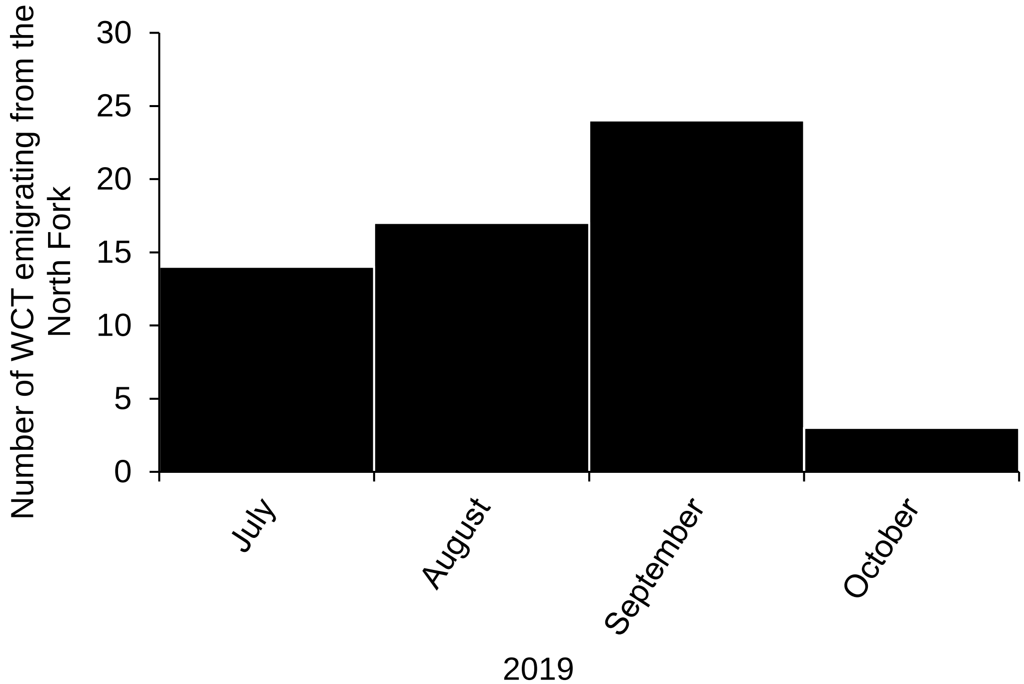

Figure 37. Frequency by month for Westslope Cutthroat Trout (WCT) tagged in the mainstem Salmon River emigrating from the North Fork Salmon River in 2019.

WILD TROUT REDD COUNTS

ABSTRACT

Regional fisheries staff conducted redd count surveys for resident Rainbow Trout *Oncorhynchus mykiss*, and Bull Trout *Salvelinus confluentus* populations in 2019 as part of an annual trend monitoring program. In the spring of 2019 we counted a total of 82 Rainbow Trout *O. mykiss* redds in the Big Springs Creek transect and two redds on the Lemhi River Beyeler Ranch transect. During Bull Trout redd surveys in the fall of 2019, we counted 3 redds in Alpine Creek, 9 redds in Fishhook Creek, 17 redds in 4th of July Creek, 20 redds in Hayden Creek, 63 redds in Bear Valley Creek, and 21 redds in Big Timber Creek. Overall, Rainbow Trout and Bull Trout redd counts were down across the region in 2019 when compared to 2018.

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INTRODUCTION

Salmon Region staff conduct annual redd counts for resident and fluvial Rainbow Trout *Oncorhynchus mykiss* and Bull Trout *Salvelinus confluentus* in nine streams in the region to monitor trends in spawner abundance. In 1994, we began counting Rainbow Trout redds in Big Springs Creek, a tributary to the upper Lemhi River near Leadore, and in 1997 another transect was established for Rainbow Trout on the upper Lemhi River, just above the confluence with Big Springs Creek. Redd count monitoring for Rainbow Trout on these transects provides a general indication of population abundance trends over time. Numerous habitat improvement projects, changes in water-use practices, alterations in land management practices, and fisheries regulation changes have occurred in the upper Lemhi River basin in the last decade, all of which may have benefited resident fish populations. Continuing the annual redd counts for resident trout is could lend insights as to whether fish habitat restoration, land use conservation or fishing regulation changes may be affecting the population.

In addition to Rainbow Trout counts, Bull Trout redd counts are an important monitoring tool for both migratory and resident native char. Bull Trout were listed as threatened under the Endangered Species Act (ESA) on June 10, 1998. That fall, the Salmon Region's first trend transects for enumerating Bull Trout redds were established. Trend transects were established on Alpine and Fishhook creeks in the Sawtooth Valley, near Stanley in 1998. Bear Valley Creek and East Fork Hayden Creek transects in the Lemhi River drainage were established in 2002. Transects on Fourth of July Creek in the Sawtooth Valley were added in 2003, and on Upper Hayden Creek in the Lemhi River drainage in 2006.

Over the years, as additional spawning areas have been located (outside of established transect boundaries), new trend transects have been added to encompass as much spawning production as possible. New transects were added on Bear Valley Creek in 2007, Fishhook Creek in 2008, and on Alpine Creek in 2011. In upper Hayden Creek, the trend transect was moved altogether in 2010, when staff determined the existing transect was too low in the drainage and most Bull Trout spawning occurred much higher.

OBJECTIVES

1. Maintain trend monitoring datasets for spawning resident and fluvial trout in the region by continuing annual redd counts and operating fish weirs in priority tributaries.

STUDY SITES AND METHODS

Rainbow Trout Redd Count Monitoring

Big Springs Creek

Big Springs Creek is a tributary to the Lemhi River, located approximately 8 km north of Leadore, Idaho. Two trend transects (Tyler transect and Neibaur transect) are walked on Big Springs Creek annually (Appendix C).

Redd counts are usually conducted during the last week of April or the first week of May on Big Springs Creek. The counts are "single pass" counts, where redds are counted on a single occasion and are not flagged. Redd counts on Big Springs Creek were conducted on May 3 in 2019.

Lemhi River

The Lemhi River flows approximately 100 km from its headwaters near Leadore, Idaho to its confluence with the Salmon River at Salmon, Idaho. The upper Lemhi River redd count trend transect was established in 1997 and includes a 3-km section of the Lemhi River flowing through the Merrill Beyeler Ranch from the fence line 100 m upstream of the upper water gap to the lower fenced boundary (Appendix C).

Redd counts are usually conducted during the last week of April or the first week of May, at the same time and using the same methods as for Big Springs Creek (single pass). Redd counts were conducted on May 3, 2019.

Bull Trout Redd Count Monitoring

Alpine Creek

Alpine Creek is a tributary to Alturas Lake Creek, which flows into Alturas Lake in the Sawtooth Valley, approximately 35 km south of Stanley, Idaho. Two trend transects are walked annually on Alpine Creek (i.e., older and newer) (Appendix C).

Historically, two visual ground counts are conducted annually, about two weeks apart, on both transects in Alpine Creek. Since 2015 only one count has been conducted. This count usually falls between September 3rd and September 12th depending on crew availability and other regional needs. The survey in 2019 was conducted on September 5. For each transect, all redds in progress or completed redds were counted during the survey.

Fishhook Creek

Fishhook Creek is a tributary of Redfish Lake in the Sawtooth Valley, approximately 10 km south of Stanley, Idaho. Two trend transects are walked on Fishhook Creek annually (i.e., older and newer) (Appendix A).

Prior to 2015, two visual ground counts were conducted annually, about two weeks apart, on each of the two Fishhook Creek transects. This count usually falls between September 3rd and September 12th depending on crew availability and other regional needs. The survey on Fishhook Creek was conducted on September 5, 2019. For each transect, all redds in progress or completed redds were counted during the survey.

Fourth of July Creek

Fourth of July Creek is a tributary of the upper Salmon River in the Sawtooth Valley, located approximately 28 km south of Stanley, Idaho. One single visual ground count is conducted on Fourth of July Creek annually (Appendix C).

Fisheries staff conducted a redd count survey for Bull Trout in Fourth of July Creek on September 12, 2019. Redd counts on Fourth of July Creek are “single pass” counts, meaning redds are enumerated on a single occasion and are not flagged.

Hayden Creek

Hayden Creek is the largest tributary to the Lemhi River. Two trend transects were surveyed on Hayden Creek (Appendix C) in 2019. The older transect produced single digit Bull Trout redd counts each year between 2006 and 2009. In 2010, the transect boundaries were moved upstream to the current location (newer; Messner et al. 2016) to encompass the bulk of spawning activity (M. Biggs, IDFG, personal communication). Two additional transects were also surveyed in 2019 that were established in 2018 while conducting redd surveys for Chinook Salmon *Oncorhynchus tshawytscha.* The first of these transects was from the slide area on Hayden Creek to Tobias Fence. The second transect was from a bridge located below Hayden pond to the HC 10/11 Bridge.

Both fluvial and resident forms of Bull Trout are found in upper Hayden Creek. The newer Hayden Creek trend transect is typically walked twice annually, approximately one week apart, to visually count fluvial and resident Bull Trout redds. The older transect was surveyed on August 27, September 4, and 20 in 2019. Whereas, the newer transect was surveyed on September 17, 2019. Since fluvial Bull Trout are larger in size than residents, fluvial Bull Trout redds were classified as redds equal to or greater than 0.4 m by 0.6 m in diameter while redds smaller in size were considered those of resident Bull Trout. For the newer transect, all redds in progress or completed redds were counted during the first survey and flagged. On the second survey in each transect, additional completed redds were counted and included with the number of flagged redds to provide a total number of redds. Redd counts in the newer transect were “single pass” counts and therefore all redds were enumerated during a single survey and were not flagged.

Bear Valley Creek

Bear Valley Creek is a tributary of Hayden Creek in the Lemhi River drainage, located approximately 60 km south of Salmon, Idaho. Two trend transects are walked annually on Bear Valley Creek to enumerate Bull Trout redds (i.e., older and newer; Appendix C).

Two to three visual ground counts are conducted annually about one week apart on the Bear Valley Creek transects. A third pass is typically only conducted when the ratio of live fish to redds is greater than one on the second pass. In 2019, five counts were conducted between August 27 and September 25. Since fluvial Bull Trout are larger in size than residents, fluvial Bull Trout redds were classified as redds equal to or greater than 0.4 m by 0.6 m in diameter, while redds that were smaller in size were considered those of resident Bull Trout. For each transect, all redds in progress or completed redds were counted during the first survey and flagged. On the second and third passes in each transect, additional completed redds were counted and included with the number of flagged redds to provide a total number of redds.

East Fork Hayden Creek

Bull Trout redd counts on East Fork Hayden Creek were not conducted in 2019 due to time constraints.

Big Timber Creek

Big Timber Creek is a tributary of the Lemhi River located approximately 3 km west of Leadore, Idaho. In 2019, three transects were walked in Big Timber Creek to estimate Chinook Salmon redd abundance and Bull Trout redd counts were conducted concurrently. Transects were surveyed with a double or triple pass and all redds were enumerated. Surveys took place between September 5th and September 19, 2019. The first transect was from 3.2 km upstream of Rocky Creek downstream to Rocky Creek. The second transect is in Rocky Creek, a tributary of Big Timber Creek. This transect runs from the middle of Rocky Creek downstream to the mouth of Rocky Creek. The third transect is from the mouth of Rocky Creek downstream to the mouth of Grove Creek on Big Timber Creek (Appendix C).

RESULTS AND DISCUSSION

Rainbow Trout Redd Count Monitoring

Big Springs Creek and Lemhi River

Fisheries staff observed 82 Rainbow Trout redds in Big Springs in 2019 (Table 20; Figure 34). On Big Springs Creek, 50 redds were counted in the historic Neibaur Ranch transect while 32 redds were observed in the Tyler Ranch transect (Table 26). Only two redds were counted in the Beyeler reach of the Lemhi River. The total number of redds counted in 2019 was one of the lowest counts since 1997 (Figure 38). The 2012 to 2014 trend counts were three of the four highest counts on record, but spawner abundance decreased in 2015 and has remained relatively low from 2017 to 2019. The overall trend count in 2019 was below average relative to the past 10 years of data (Figure 34). These transects will continue to be monitored annually.

Bull Trout Redd Count Monitoring

Alpine Creek

In 2019, we observed 3 Bull Trout redds in the upper transect in Alpine Creek (Table 27, Figure 39). In the lower (newer) trend transect, two redds were observed in 2019 (Figure 39). Zero redds were observed in the upper transect in 2018. Prior to 2013, no Bull Trout redds, or live fish, had been observed in the upper trend area in five years. The number of Bull Trout redds observed in Alpine Creek in 2019 was a decrease from the number of redds observed in 2016 and 2017, but was similar to the total number of redds in 2013 - 2015 (Figure 39). Numbers of redds observed in this transect has been low since then, but in 2017 relatively recent beaver activity was documented which seems to have increased spawning habitat quality in the lower end of the upper transect. Perhaps this will result in a greater number of redds in this transect in future years. Since 2015, dates walked for this transect range from September 3rd to September 12. Prior to 2015, this transect was walked twice, with the first walk being near the 28th - 30th of August and the second walk near the 12th of September. By conducting a single survey towards the earlier timeslot, we may be underestimating total redds in Alpine Creek. Since 2006, redd counts in Alpine Creek have been consistently down. One reason for this may be the change in Sockeye Salmon stocking into Alturas Lake. IDFG has not stocked any sockeye into Alturas Lake since 2011. Sockeye Salmon fingerlings may be an important component in the diet of Alturas

Lake Bull Trout and likely easier to prey upon than catchable-size Rainbow Trout that are stocked several times during the summer annually.

Fishhook Creek

Two Bull Trout redds were observed in the upper trend transect in Fishhook Creek in 2019, and 7 redds were counted in the lower (newer) transect. This is the lowest redd count in Fishhook Creek since surveys began in 1998 (Table 27; Figure 40). Redd counts appear to be quite variable, having peaked in 2015-2016. Prior to 2015, Bull Trout redd numbers in Fishhook Creek have remained relatively consistent over the years, suggesting a stable population (mean ± SE = 16.6 ± 2.1). The higher redd counts in 2015, 2016, and 2018 may result in increased redd numbers in the near future if survival is good for those cohorts produced. Since 2015, dates walked for this transect range from September 3rd to September 12th. Prior to 2015 this transect was walked twice with the first walk being near the 28th - 30th of August and the second walk near the 12th of September. By conducting the survey towards the earlier timeslot we may be underestimating total redds in Fishhook Creek. Determining the age-structure of the spawning population of Bull Trout in this tributary (and others) could help provide insight on when we could expect to see peaks and valleys in the spawner abundance trend figures. The decline in redd counts in Fish Hook Creek corresponds with a similar decline for nearby Fourth of July Creek. Spawner abundance in the Stanley Basin appears to be highly variable, however as mentioned above there may be a strong upward trend in spawner abundance in the coming years. It is unknown if these changed are actual changes in Bull Trout abundance or if there is a response to environmental conditions, or if Bull Trout are using an alternate year spawning strategy in these drainages. These trends warrant further investigation and modeling using environmental conditions to gain a better understanding of what factors influence the observed changes in spawner abundance.

Fourth of July Creek

Staff counted 17 completed Bull Trout redds in the Fourth of July Creek trend transect in 2019 (Table 27, Figure 41). Based on a pattern that emerged in the data since we began monitoring redd abundance in 2003, we expected to see relatively high abundance of redds in Fourth of July Creek in 2016, but this was not the case. Previously, there appeared to be a peak in abundance in five-year cycles. However, redd abundance in 2018 tracked similarly to what would be expected given the aforementioned trend (Figure 41). Based on that same trend, we expected 2019 to produce a slightly lower abundance of redds than 2018. However we did not expect redd counts to decrease by approximately two-thirds. A similar trend was seen in Fishhook Creek. Redd counts in Fourth of July Creek appear to peak every fourth year. As mentioned above, the high variability of these trends should be investigated further to determine if environmental factors, year effects, or life history variations are driving them.

Hayden Creek

Fifteen Bull Trout redds were counted in the newer Hayden Creek trend site in 2019 (Table 28, Figure 41). Five were estimated to be fluvial size (25%) and 10 were resident size (75%). Only five redds were observed in the older Hayden Creek trend site which is much lower than previous surveys, which never documented fewer than 22 redds during 2005-2009 period (Figure 42). Similar to Bull Trout redd counts on other Lemhi River tributaries, Bull Trout redd counts in Hayden

Creek were down in 2019. Hayden Creek serves as a reference stream for the Lemhi Intensively Monitored Watershed project (IMW). Information generated from this project such as Chinook redd counts, anadromous fry production, fish densities, and anadromous parr and smolt emigration via a rotary screw trap may be useful to further understand what may be driving trends in Bull Trout redd counts.

Bear Valley Creek

Regional fisheries staff counted 20 Bull Trout redds in the older Bear Valley Creek trend transect in 2019 and 43 redds in the newer trend transect, for a total of 63 redds (Table 28; Figure 43). Twenty redds were estimated as fluvial size (32%) and 43 as resident size. Bull Trout redds have been below the average of 102 (SD = 41) since 2016. Bear Valley Creek typically has the highest redd count of all streams that we survey for Bull Trout redds. As mentioned above, the Hayden Creek drainage, including Bear Valley Creek serve as the reference stream for the Lemhi Intensively Monitored Watershed (IMW) project when evaluating restoration actions on other streams. These two streams (Hayden and Bear Valley) could be used as an indicator of overall Bull Trout production in the basin.

East Fork Hayden Creek

Bull Trout redds were not counted in the East Fork of Hayden Creek in 2019.

Big Timber Creek

A total of 21 Bull Trout redds were observed in Big Timber Creek in 2019, 20 of which were assigned to be from resident Bull Trout. The single fluvial redd was in the Grove Creek – Rocky Creek transect, in addition to two more resident size redds. Six redds were found in the transect above Rocky Creek. Thirteen redds were found in the Rocky Creek transect (Table 29).

Overall Bull Trout redd abundance in the Upper Salmon Basin appears to be highly variable year-to-year. Roth et al. (2021) examined yearly survival of Bull Trout in the East Fork Salmon River. They found that the number of emigrating salmonid smolts in the upper Salmon River positively influenced growth and survival of Bull Trout in the East Fork Salmon River. When growth is positively influenced, it can also be assumed that fecundity and overall health are also positively influenced, and this may account for some of the variability in the overall abundance of Bull Trout redds observed in Region 7. Furthermore, we know many of the Bull Trout from these tributaries overwinter in the mainstem Salmon River (Schoby 2006). Thus they are likely exposed to similar effects that influence survival, growth, and fecundity. A basin-wide, or Hayden Creek centered analysis based on redd abundance versus smolt abundance and environmental factors would likely help to identify some factors driving the high variability of Bull Trout spawner abundance observed in the Upper Salmon River region.

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring trends in redd counts for resident trout populations in designated transects.

2. Investigate variability in Bull Trout Redd abundance through a basin-wide analysis of redd abundance, smolt abundance, and environmental factors.

Table 26. Summary of Rainbow Trout redds counted in the upper Lemhi River and Big Springs Creek (BSC) transects, 1994 – 2019.

Year	Big Springs Creek Neibaur Ranch	Big Springs Creek Tyler Ranch	Lemhi River Beyeler Ranch	Total
1994	--	--	--	40
1995	57	--	--	57
1996	32	--	7	39
1997	44	45	8	97
1998	93	124	18	235
1999	39	71	29	139
2000	160	123	23	306
2001	95	186	2	283
2002	360	193	3	556
2003	128	103	56	287
2004	174	45	15	234
2005	75	43	3	121
2006	63	143	9	215
2007	163	62	8	233
2008	82	108	9	199
2009	100	54	10	164
2010	132	57	18	207
2011	103	49	20	172
2012	130	224	14	368
2013	159	122	49	330
2014	185	280	93	558
2015	65	60	75	200
2016	124	66	46	236
2017	52	46	139	237
2018	60	39	11	110
2019	50	32	2	84

Table 27. Summary of Bull Trout redd counts in Alpine Creek (tributary to Alturas Lake Creek), Fish Hook Creek (tributary to Redfish Lake), and Fourth of July Creek (tributary to upper Salmon River) from 1998-2019.

Stream	Year	Older transect redds	Newer transect redds	Total redds
Alpine Creek	1998	1	--	1
	1999	3	--	3
	2000	9	--	9
	2001	15	--	15
	2002	14	--	14
	2003	14	--	14
	2004	9	--	9
	2005	13	--	13
	2006	13	--	13
	2007	18	--	18
	2008	0	--	0
	2009	0	--	0
	2010	0	1	1
	2011	0	2	2
	2012	0	0	0
	2013	1	2	3
	2014	4	0	4
	2015	3	0	3
	2016	6	7	13
	2017	0	12	12
	2018	0	1	1
	2019	3	2	5
Fishhook Creek	1998	11	--	11
	1999	15	--	15
	2000	18	--	18
	2001	26	--	26
	2002	17	--	17
	2003	17	--	17
	2004	11	--	11
	2005	23	--	23
	2006	25	--	25
	2007	22	--	22
	2008	13	14	27
	2009	21	12	33
	2010	17	10	27
	2011	11	7	18
	2012	21	9	30
	2013	15	13	28
	2014	6	8	14

Table 27 (continued)

Stream	Year	Older transect redds	Newer transect redds	Total redds
Fishhook Creek	2015	61	2	63
	2016	47	13	60
	2017	12	2	14
	2018	21	10	31
	2019	2	7	9
Fourth of July Creek	2003	16	--	16
	2004	33	--	33
	2005	41	--	41
	2006	71	--	71
	2007	49	--	49
	2008	25[a]	--	25[a]
	2009	50	--	50
	2010	56	--	56
	2011	51	--	51
	2012	50[a]	--	50[a]
	2013	21	--	21
	2014	85	--	85
	2015	48[a]	--	48[a]
	2016	8	--	8
	2017	39	--	39
	2018	59	--	59
	2019	17	--	17

[a] Numbers reported incorrectly in 2015 annual report

Table 28. Bull Trout redds counted in the Hayden Creek drainage in the Lemhi River basin, 2002 – 2019.

Stream	Year	Older transect redds	Newer transect redds	Total redds
Bear Valley Creek	2002	26	--	26
	2003	42	--	42
	2004	44	--	44
	2005	34	--	34
	2006	26	60	86
	2007	25	115	140
	2008	27	21	48
	2009	42	24	66
	2010	37	22	59
	2011	36	103	139
	2012	33	91	124
	2013	41	78	119
	2014	66	134	200
	2015	39	98	137
	2016	30	59	89
	2017	24	53	77
	2018	28	51	79
	2019	43	20	63
Hayden Creek	2005	22	--	22
	2006	74	--	74
	2007	115	--	115
	2008	28	--	28
	2009	22	--	22
	2010	--	29	29
	2011	--	49	49
	2012	--	39	39
	2013	--	14	14
	2014	--	29	29
	2015	--	18	18
	2016	--	41	41
	2017	--	43	43
	2018	4	18	22
	2019	5	10	15

Table 29. Bull trout redds counted in the Big Timber Creek drainage in the Lemhi River basin, 2007 – 2019.

Year	Big Timber Cr	Rocky Cr	Total redds
2007	8	7	15
2008	2	6	8
2009	--	--	--
2010	5	16	21
2011	1	35	36
2012	23	29	52
2013	--	--	--
2014	17	31	48
2015	33	33	66
2016	17	--	17
2017	--	--	--
2018	4	--	4
2019	9	13	22

"—" = not sampled

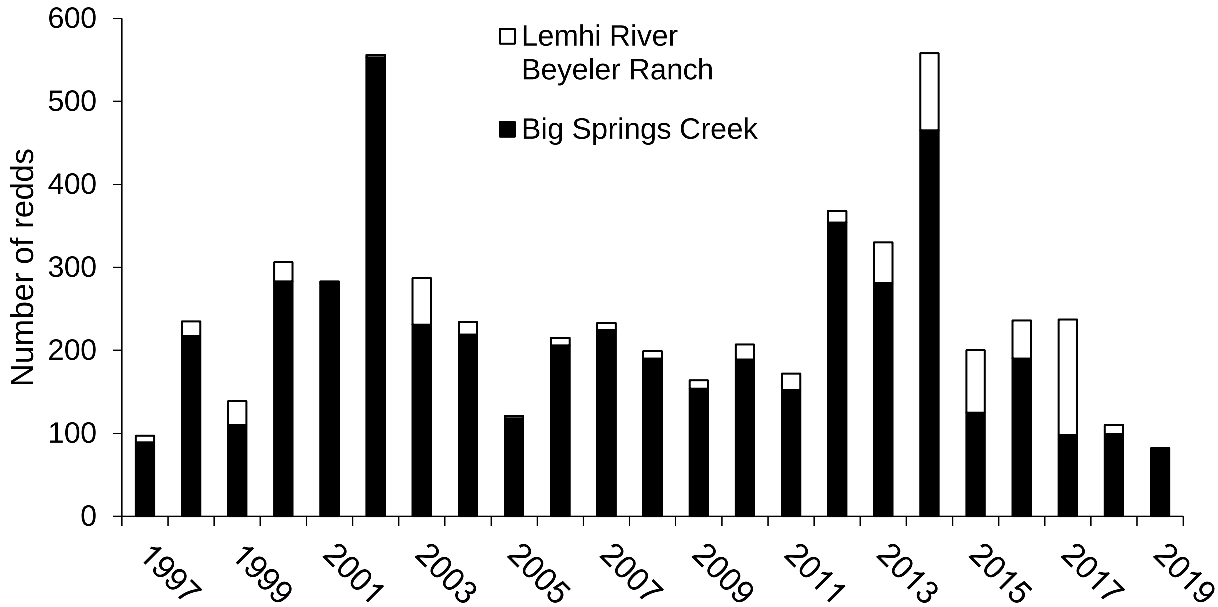

Figure 38. Resident Rainbow Trout redds counted during ground surveys in the upper Lemhi River (Beyeler Ranch) and Big Springs Creek (Neibaur and Tyler ranches), 1997 – 2019.

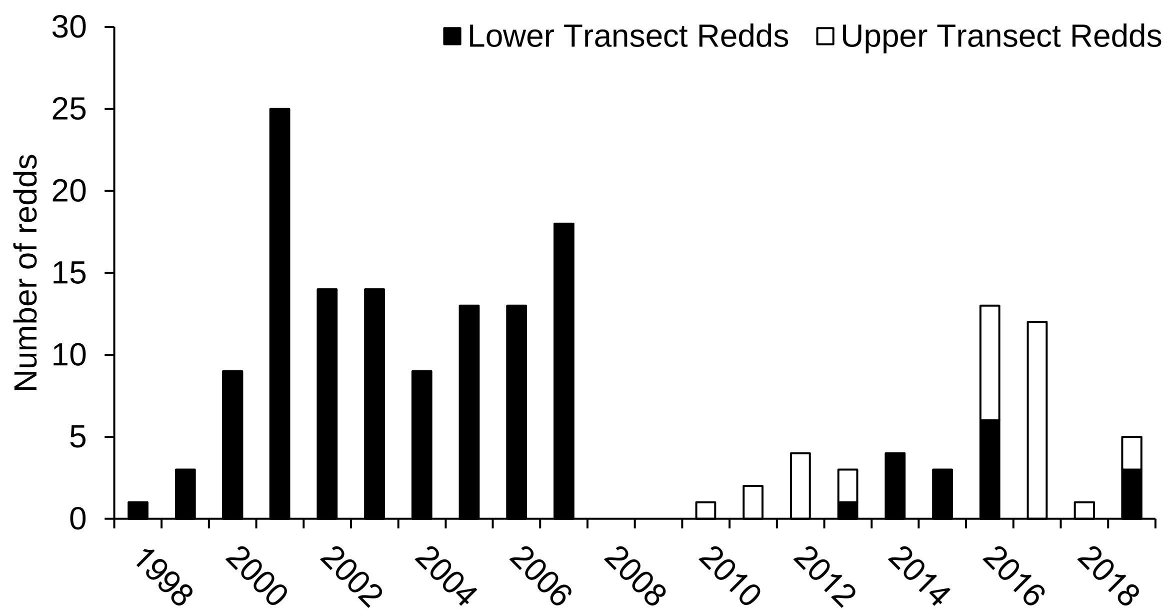

Figure 39. Number of Bull Trout redds counted in both survey transects on Alpine Creek, 1998 – 2019.

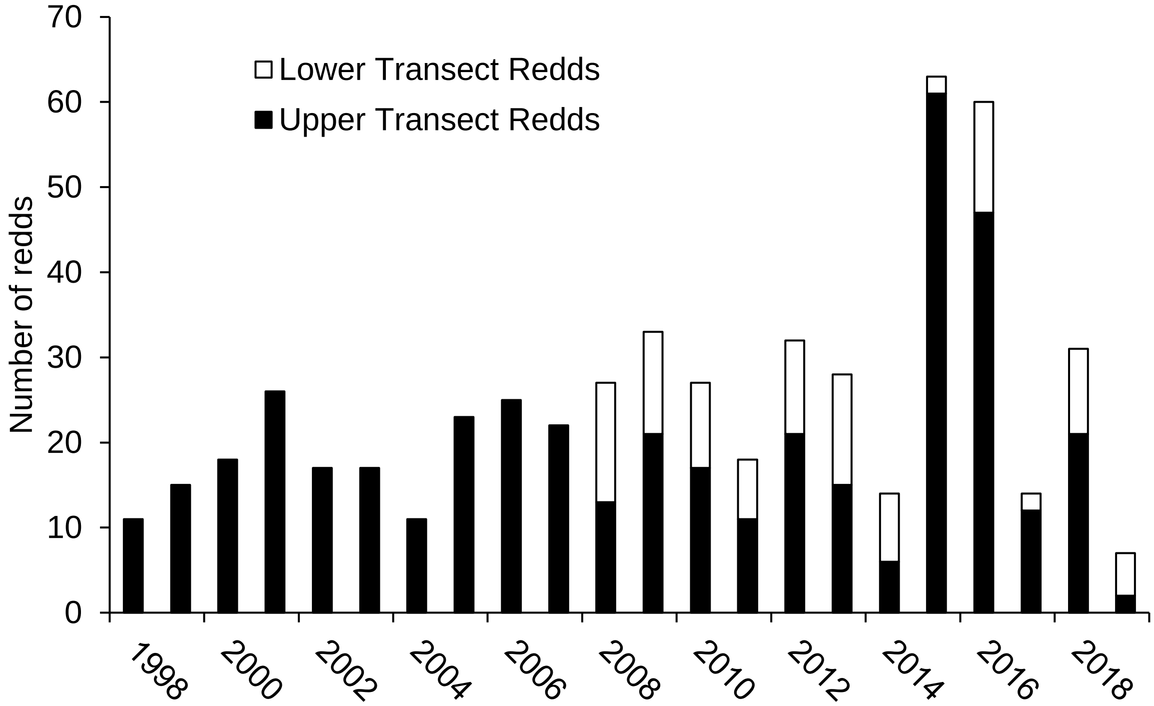

Figure 40. Number of Bull Trout redds counted in both transects on Fishhook Creek, 1998 – 2019.

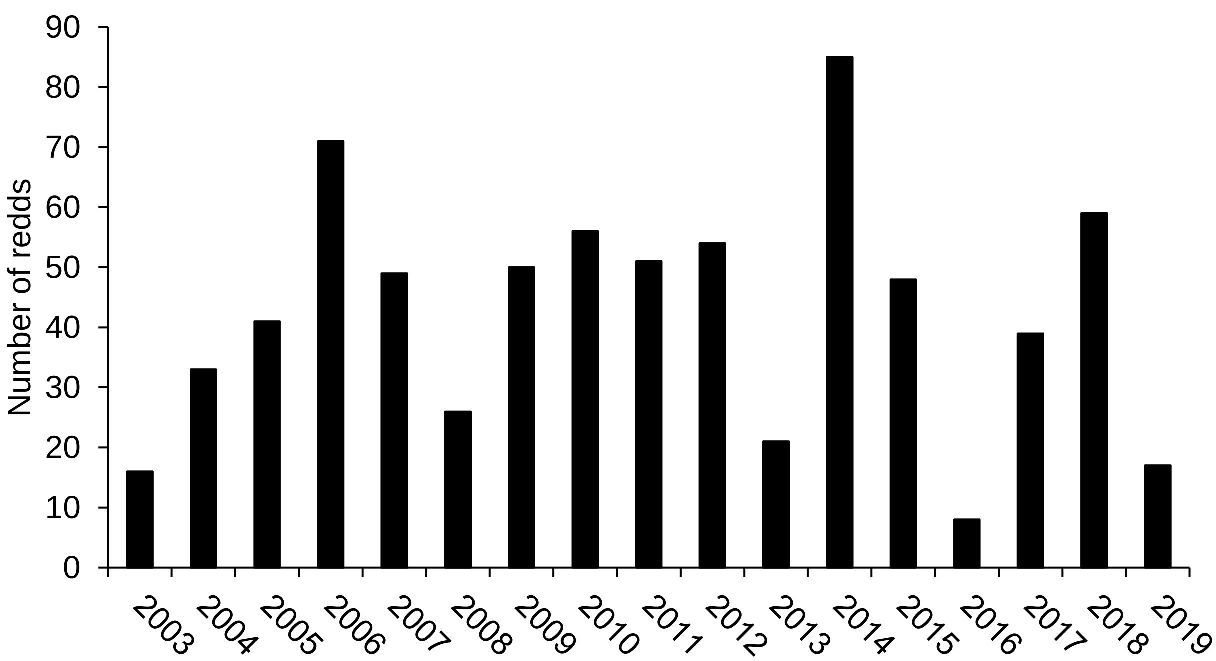

Figure 41. Number of Bull Trout redds counted on Fourth of July Creek, 2003 – 2019.

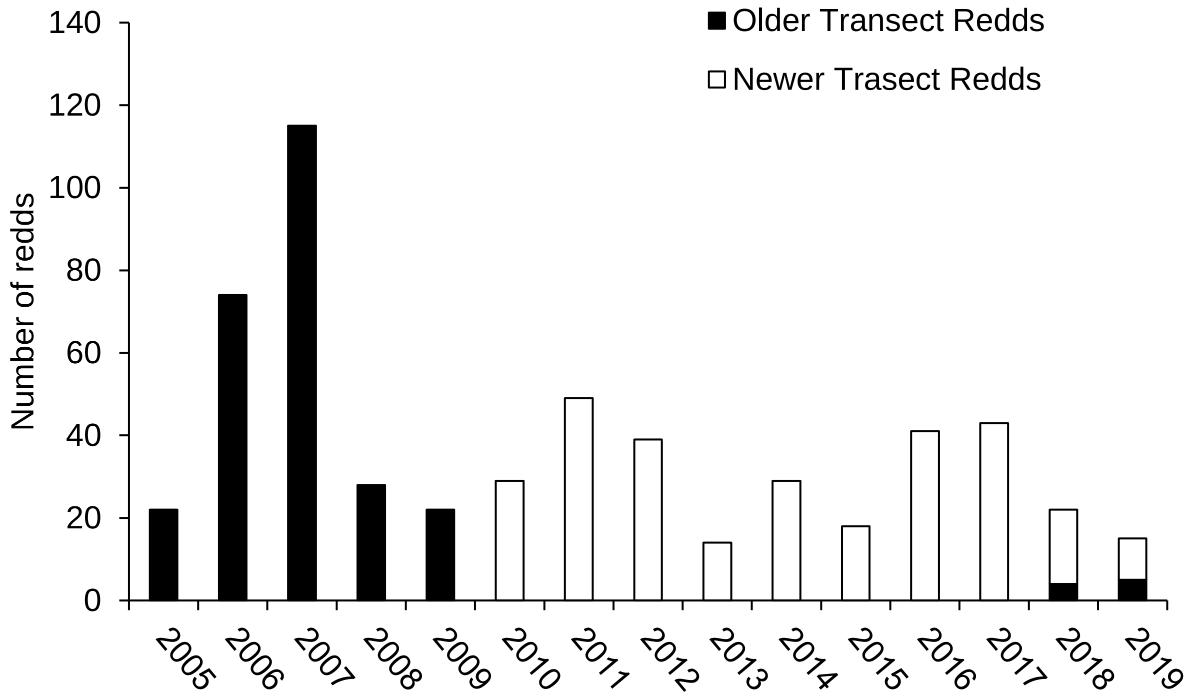

Figure 42. Number of Bull Trout redds observed in upper Hayden Creek redd count trend transects, 2005 – 2019.

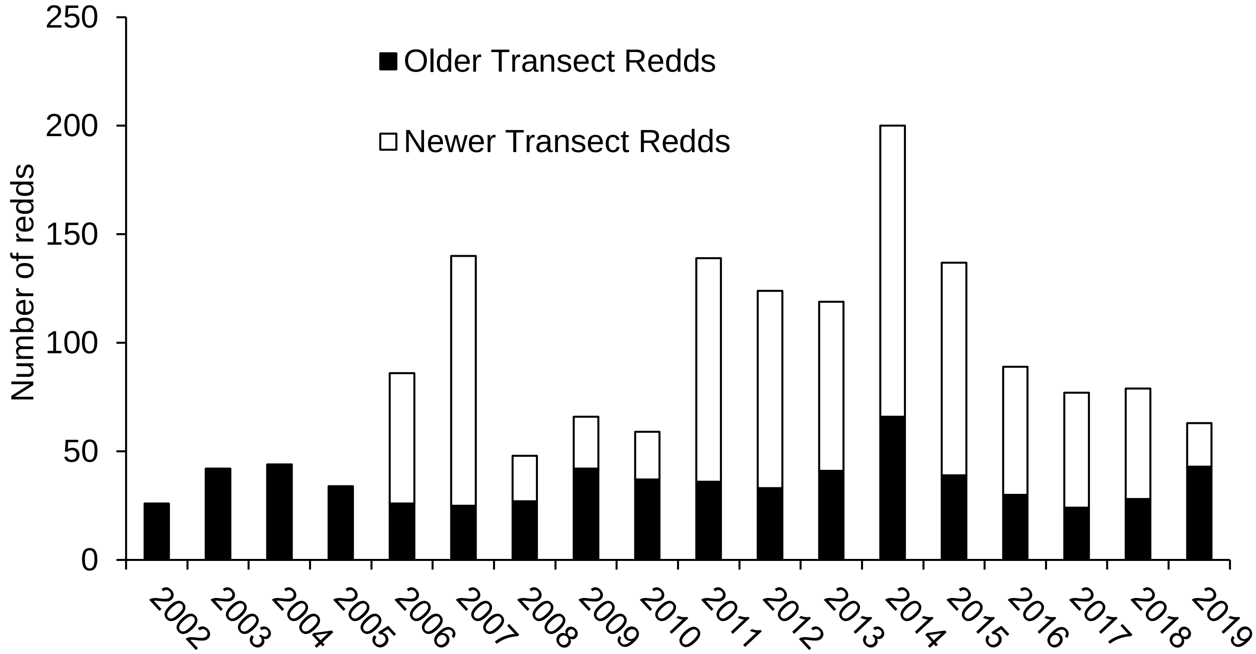

Figure 43. Number of Bull Trout redds observed in the Bear Valley Creek transects, 2002 – 2019.

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APPENDICES

Appendix A. Tag number, date tagged, observation date, length, and tagging location of *O.mykiss* tagged in 2018 in the North Fork Salmon River and tributaries and detected emigrating at the North Fork PIT-tag array in 2019 and 2020.

Tag	Tag date	Obs. date	Length (mm)	Tag location
3DD.003D2C51F6	8/12/2018	4/8/2019	182	NFSR - Boyne Property
3DD.003D2C51FD	8/12/2018	5/12/2019	175	NFSR - Boyne Property
3DD.003D2C5220	8/12/2018	10/1/2019	161	NFSR - Boyne Property
3DD.003D2C4E89	8/13/2018	9/11/2019	120	NFSR - Boyne Property
3DD.003D2C4E8E	8/13/2018	5/12/2019	188	NFSR - Boyne Property
3DD.003D2C4E8F	8/13/2018	5/12/2019	147	NFSR - Boyne Property
3DD.003D2C4E97	8/13/2018	4/25/2019	128	NFSR - Boyne Property
3DD.003D2C4EC5	8/13/2018	9/5/2019	118	NFSR - Boyne Property
3DD.003D2C520E	8/12/2018	5/30/2019	154	NFSR - Boyne Property
3DD.003D2C520F	8/13/2018	5/13/2019	167	NFSR - Boyne Property
3DD.003D2C524E	8/13/2018	5/12/2019	131	NFSR - Boyne Property
3DD.003D2C5256	8/13/2018	4/26/2019	178	NFSR - Boyne Property
3DD.003D2C4FEC	7/1/2018	4/30/2020	101	Dahlonega Creek - SNFDC-02
3DD.003D2C4FDD	6/27/2018	11/24/2019	106	Dahlonega Creek - SNFDC-03
3DD.003D2C4FE1	6/27/2018	5/28/2019	146	Dahlonega Creek - SNFDC-03
3DD.003D2C4FFB	6/27/2018	6/10/2019	140	Dahlonega Creek - SNFDC-03
3DD.003D2D31A3	7/10/2018	10/6/2019	99	Hughes Creek - SNFHC-02
3DD.003D2D3258	7/10/2018	5/12/2019	134	Hughes Creek - SNFHC-02
3DD.003D2D3262	7/10/2018	5/12/2019	161	Hughes Creek - SNFHC-02
3DD.003D2D326D	7/10/2018	4/24/2019	149	Hughes Creek - SNFHC-02
3DD.003D2D32A4	7/10/2018	4/29/2019	149	Hughes Creek - SNFHC-02

Appendix A (continued)

Tag	Tag date	Obs. date	Length (mm)	Tag location
3DD.003D2D324F	7/10/2018	5/7/2019	154	Hughes Creek - SNFHC-03
3DD.003D2D31C8	7/10/2018	5/12/2019	167	Hughes Creek - SNFHC-05
3DD.003D2D32A3	7/10/2018	4/21/2019	135	Hughes Creek - SNFHC-05
3DD.003D2C4E92	8/13/2018	5/2/2019	173	NFSR - Phil treatment
3DD.003D2C4E92	8/13/2018	5/3/2019	173	NFSR - Phil treatment
3DD.003D2C4E98	8/13/2018	5/9/2019	174	NFSR - Phil treatment
3DD.003D2C4ED4	8/13/2018	10/5/2019	112	NFSR - Phil treatment
3DD.003D2C4F3F	8/15/2018	5/25/2019	135	NFSR - Phil treatment
3DD.003D2C4F4B	8/15/2018	5/14/2019	169	NFSR - Phil treatment
3DD.003D2C4F4C	8/15/2018	4/23/2020	108	NFSR - Phil treatment
3DD.003D2C4F59	8/15/2018	5/3/2019	143	NFSR - Phil treatment
3DD.003D2C4F5B	8/15/2018	5/12/2019	158	NFSR - Phil treatment
3DD.003D2C4F63	8/15/2018	4/4/2019	145	NFSR - Phil treatment
3DD.003D2C4F6D	8/15/2018	5/10/2020	103	NFSR - Phil treatment
3DD.003D2C4F70	8/15/2018	4/21/2019	175	NFSR - Phil treatment
3DD.003D2C4F72	8/13/2018	12/16/2019	126	NFSR - Phil treatment
3DD.003D2C4F7A	8/15/2018	10/5/2019	130	NFSR - Phil treatment
3DD.003D2C4F7F	8/13/2018	4/4/2020	123	NFSR - Phil treatment
3DD.003D2C4F87	8/15/2018	10/5/2019	137	NFSR - Phil treatment
3DD.003D2C521B	8/15/2018	7/6/2019	116	NFSR - Phil treatment
3DD.003D2D318C	7/8/2018	10/7/2019	92	NFSR - Phil treatment
3DD.003D2D31B7	7/8/2018	5/4/2019	160	NFSR - Phil treatment
3DD.003D2D31D0	7/8/2018	4/25/2019	115	NFSR - Phil treatment
3DD.003D2D3260	7/8/2018	4/23/2020	98	NFSR - Phil treatment
3DD.003D2D3261	7/8/2018	4/26/2019	149	NFSR - Phil treatment
3DD.003D2C4EE2	7/11/2018	5/2/2020	133	NFSR - SNF-08
3DD.003D2C4EE6	7/11/2018	9/25/2019	122	NFSR - SNF-08
3DD.003D2C4F0A	7/11/2018	4/9/2019	193	NFSR - SNF-08
3DD.003D2C4FAF	7/2/2018	4/25/2019	144	NFSR - SNF-09
3DD.003D2C4FB6	7/2/2018	5/27/2019	141	NFSR - SNF-09

Appendix A (continued)

Tag	Tag date	Obs. date	Length (mm)	Tag location
3DD.003D2C4EDD	7/11/2018	5/11/2020	125	NFSR - SNF-10A
3DD.003D2C4F13	7/11/2018	5/16/2020	128	NFSR - SNF-10A
3DD.003D2C4F29	7/11/2018	5/6/2019	140	NFSR - SNF-10A
3DD.003D2C4EB7	8/15/2018	4/23/2019	146	NFSR - Thomas control
3DD.003D2C4EDC	8/12/2018	4/23/2020	128	NFSR - Thomas control
3DD.003D2C4EFA	8/12/2018	4/24/2019	128	NFSR - Thomas control
3DD.003D2C4F11	8/12/2018	9/27/2019	106	NFSR - Thomas control
3DD.003D2C4F25	8/12/2018	4/30/2020	130	NFSR - Thomas control
3DD.003D2C4F2E	8/12/2018	10/4/2019	198	NFSR - Thomas control
3DD.003D2C4F2E	8/12/2018	3/21/2020	198	NFSR - Thomas control
3DD.003D2C4F2E	8/12/2018	9/14/2020	198	NFSR - Thomas control
3DD.003D2C4F39	8/15/2018	5/10/2019	124	NFSR - Thomas control
3DD.003D2C4F42	8/15/2018	5/7/2019	128	NFSR - Thomas control
3DD.003D2C4F54	8/15/2018	4/25/2019	184	NFSR - Thomas control
3DD.003D2C4F73	8/15/2018	4/8/2019	122	NFSR - Thomas control
3DD.003D2C4F75	8/15/2018	4/26/2019	97	NFSR - Thomas control
3DD.003D2C4F7C	8/15/2018	5/12/2019	125	NFSR - Thomas control
3DD.003D2C4F96	8/15/2018	4/9/2019	183	NFSR - Thomas control
3DD.003D2C51F9	8/12/2018	4/9/2019	158	NFSR - Murphy property
3DD.003D2C5202	8/12/2018	5/8/2019	175	NFSR - Murphy property
3DD.003D2C5210	8/12/2018	5/22/2019	135	NFSR - Murphy property
3DD.003D2C5211	8/12/2018	5/12/2019	124	NFSR - Murphy property
3DD.003D2C5221	8/12/2018	4/24/2019	146	NFSR - Murphy property
3DD.003D2C522A	8/12/2018	10/6/2019	127	NFSR - Murphy property
3DD.003D2C5245	8/12/2018	4/12/2019	141	NFSR - Murphy property
3DD.003D2C5247	8/12/2018	5/7/2019	143	NFSR - Murphy property
3DD.003D2C4E74	8/13/2018	4/25/2020	121	NFSR - Murphy property

Appendix A (continued)

Tag	Tag date	Obs. date	Length (mm)	Tag location
3DD.003D2C4E7D	8/13/2018	12/22/2019	107	NFSR - Murphy property
3DD.003D2C4E91	8/13/2018	4/8/2019	143	NFSR - Murphy property
3DD.003D2C4E94	8/13/2018	5/16/2019	127	NFSR - Murphy property
3DD.003D2C5227	8/13/2018	4/26/2019	157	NFSR - Murphy property

Appendix B. Tag number, length (mm), date tagged, tag location (Salmon River sampling transect), date entered North Fork Salmon River (NF), date exited NF, and duration in NF for Westslope Cutthroat Trout PIT-tagged in the mainstem Salmon in 2018.

Tag number	Length (mm)	Date tagged	Tag location (Salmon River sampling transect)	Entered NF	Exited NF	Duration in NF (days)
3D9.1C2D6F9D93	294	4/22/2018	4th of July Cr - NFSR	5/12/2019	NA	-
3D9.1C2D6FB6E8	334	4/22/2018	4th of July Cr - NFSR	5/1/2019	10/26/2019	178
3DD.003C007CEB	315	4/22/2018	4th of July Cr - NFSR	4/9/2019	9/4/2019	148
3DD.003C007D0D	265	4/22/2018	4th of July Cr - NFSR	5/24/2019	NA	-
3DD.003C007D58	327	4/22/2018	4th of July Cr - NFSR	4/18/2019	9/6/2019	141
3DD.00778C4A19	345	4/22/2018	4th of July Cr - NFSR	4/19/2019	9/8/2019	142
3DD.003C007CAC	278	4/24/2018	Bobcat - Deadwater	5/5/2019	9/7/2019	125
3DD.003C007CB5	310	4/24/2018	Bobcat - Deadwater	4/20/2019	NA	-
3DD.003C007D4C	296	4/24/2018	Bobcat - Deadwater	5/7/2019	9/8/2019	124
3DD.00778CCFC0	278	4/24/2018	Bobcat - Deadwater	5/6/2019	9/1/2019	118
3DD.003C007D93	385	10/7/2018	Morgan Bar - Red Rock	4/20/2019	7/24/2019	95
3DD.003C007D96	294	10/7/2018	Morgan Bar - Red Rock	5/6/2019	NA	-
3DD.003C007E30	356	10/7/2018	Morgan Bar - Red Rock	5/3/2019	NA	-
3DD.003D2D30BE	276	10/7/2018	Morgan Bar - Red Rock	7/16/2019	8/19/2019	34
3DD.003D2D3105	393	10/7/2018	Morgan Bar - Red Rock	4/28/2019	7/15/2019	78
3DD.003D2D310F	367	10/7/2018	Morgan Bar - Red Rock	5/12/2019	9/7/2019	118
3D9.1C2D701389	370	10/9/2018	Red Rock - NFSR	4/19/2019	NA	-
3DD.003C007D8F	340	10/9/2018	Red Rock - NFSR	4/20/2019	NA	-
3DD.003C007DB8	306	10/9/2018	Red Rock - NFSR	7/7/2019	8/7/2019	31
3DD.003C007DD8	342	10/9/2018	Red Rock - NFSR	5/5/2019	5/5/2019	-
3DD.003C007DD9	295	10/9/2018	Red Rock - NFSR	7/19/2019	9/2/2019	45
3DD.003C007DDC	277	10/9/2018	Red Rock - NFSR	7/13/2019	9/6/2019	55
3DD.003C007DE0	310	10/9/2018	Red Rock - NFSR	5/7/2019	8/26/2019	111
3DD.003C007DE3	315	10/9/2018	Red Rock - NFSR	5/5/2019	NA	-
3DD.003C007DE5	319	10/9/2018	Red Rock - NFSR	5/4/2019	NA	-
3DD.003C007DE7	349	10/9/2018	Red Rock - NFSR	4/20/2019	NA	-

Appendix B (continued)

Tag number	Length (mm)	Date tagged	Tag location (Salmon River sampling transect)	Entered NF	Exited NF	Duration in NF (days)
3DD.003C007DE9	257	10/9/2018	Red Rock - NFSR	7/13/2019	7/20/2019	7
3DD.003C007DF4	282	10/9/2018	Red Rock - NFSR	7/30/2019	NA	-
3DD.003C007DF9	310	10/9/2018	Red Rock - NFSR	6/13/2019	7/8/2019	25
3DD.003C007DFC	316	10/9/2018	Red Rock - NFSR	5/7/2019	NA	-
3DD.003C007E00	360	10/9/2018	Red Rock - NFSR	4/20/2019	NA	-
3DD.003C007E0B	360	10/9/2018	Red Rock - NFSR	4/21/2019	4/22/2019	1
3DD.003C007E15	384	10/9/2018	Red Rock - NFSR	4/23/2019	NA	-
3DD.003C007E18	345	10/9/2018	Red Rock - NFSR	5/6/2019	NA	-
3DD.003C007E19	331	10/9/2018	Red Rock - NFSR	4/20/2019	9/13/2019	146
3DD.003C007E1A	390	10/9/2018	Red Rock - NFSR	4/23/2019	7/20/2019	88
3DD.003C007E25	330	10/9/2018	Red Rock - NFSR	6/26/2019	NA	-
3DD.003C007E2E	360	10/9/2018	Red Rock - NFSR	5/4/2019	NA	-
3DD.003C007E32	340	10/9/2018	Red Rock - NFSR	5/5/2019	NA	-
3DD.003D2D30C0	325	10/9/2018	Red Rock - NFSR	4/20/2019	8/30/2019	132
3DD.003D2D30C5	305	10/9/2018	Red Rock - NFSR	4/9/2019	NA	-
3DD.003D2D30CD	420	10/9/2018	Red Rock - NFSR	4/9/2019	6/18/2019	70
3DD.003D2D30FC	327	10/9/2018	Red Rock - NFSR	5/3/2019	10/5/2019	155
3DD.003D2D3131	292	10/9/2018	Red Rock - NFSR	4/20/2019	NA	-
3DD.003D2D32AA	360	10/9/2018	Red Rock - NFSR	5/8/2019	NA	-
3DD.003D2D32AF	348	10/9/2018	Red Rock - NFSR	5/2/2019	8/26/2019	116
3DD.003D2D32B2	268	10/9/2018	Red Rock - NFSR	7/13/2019	10/3/2019	82
3DD.003D2D32C8	268	10/9/2018	Red Rock - NFSR	7/11/2019	8/10/2019	30
3DD.003D2D32CF	286	10/9/2018	Red Rock - NFSR	4/20/2019	9/9/2019	142
3DD.003D2D32D6	337	10/9/2018	Red Rock - NFSR	4/19/2019	8/2/2019	105
3DD.003D2D32DB	338	10/9/2018	Red Rock - NFSR	5/6/2019	7/31/2019	86
3DD.003D2D32E1	346	10/9/2018	Red Rock - NFSR	4/22/2019	9/11/2019	142
3DD.003D2D32E4	305	10/9/2018	Red Rock - NFSR	6/6/2019	9/14/2019	100
3DD.003D2D32EA	320	10/9/2018	Red Rock - NFSR	4/18/2019	NA	-
3DD.003D2D32F6	325	10/9/2018	Red Rock - NFSR	4/24/2019	NA	-

Appendix B (continued)

Tag number	Length (mm)	Date tagged	Tag location (Salmon River sampling transect)	Entered NF	Exited NF	Duration in NF (days)
3DD.003D2D32F7	324	10/9/2018	Red Rock - NFSR	5/7/2019	NA	-
3DD.003D2D32FA	341	10/9/2018	Red Rock - NFSR	4/18/2019	6/20/2019	63
3DD.003D2D3306	365	10/9/2018	Red Rock - NFSR	4/9/2019	9/17/2019	161
3DD.003D2D3307	298	10/9/2018	Red Rock - NFSR	4/27/2019	9/11/2019	137
3DD.003C007DF3	333	10/10/2018	Deadwater - Indianola	7/14/2019	9/29/2019	77
3DD.003D2D3004	339	10/10/2018	Deadwater - Indianola	9/7/2019	NA	-
3DD.003D2D3028	296	10/10/2018	Deadwater - Indianola	4/20/2019	NA	-
3DD.003D2D30F5	388	10/10/2018	Deadwater - Indianola	4/20/2019	7/14/2019	85
3DD.003D2D311E	237	10/10/2018	Deadwater - Indianola	7/19/2019	7/22/2019	3
3DD.003D2D2EC4	386	10/15/2018	Morgan Bar - Red Rock	4/17/2019	NA	-
3DD.003D2D2ECF	335	10/15/2018	Morgan Bar - Red Rock	5/4/2019	NA	-
3DD.003D2D2F1A	369	10/15/2018	Morgan Bar - Red Rock	4/14/2019	9/28/2019	167
3DD.003D2D31E9	377	10/15/2018	Morgan Bar - Red Rock	4/8/2019	9/7/2019	152
3DD.003D2D320D	349	10/15/2018	Morgan Bar - Red Rock	5/6/2019	6/30/2019	55
3DD.003D2D3229	400	10/15/2018	Morgan Bar - Red Rock	4/18/2019	NA	-
3DD.003D2D2E68	375	10/16/2018	Red Rock - NFSR	4/18/2019	NA	-
3DD.003D2D2EC8	350	10/16/2018	Red Rock - NFSR	5/4/2019	7/11/2019	68
3DD.003D2D2ECC	356	10/16/2018	Red Rock - NFSR	5/4/2019	NA	-
3DD.003D2D2ED2	305	10/16/2018	Red Rock - NFSR	5/14/2019	6/27/2019	44
3DD.003D2D2ED4	267	10/16/2018	Red Rock - NFSR	7/7/2019	8/23/2019	47
3DD.003D2D2EDA	280	10/16/2018	Red Rock - NFSR	4/20/2019	NA	-
3DD.003D2D2EDB	350	10/16/2018	Red Rock - NFSR	4/18/2019	8/10/2019	114
3DD.003D2D2EDC	338	10/16/2018	Red Rock - NFSR	4/28/2019	6/19/2019	52
3DD.003D2D2EDF	335	10/16/2018	Red Rock - NFSR	4/19/2019	NA	-
3DD.003D2D2EE2	325	10/16/2018	Red Rock - NFSR	5/5/2019	NA	-
3DD.003D2D2EE9	254	10/16/2018	Red Rock - NFSR	6/13/2019	NA	-
3DD.003D2D2EF7	390	10/16/2018	Red Rock - NFSR	4/18/2019	7/3/2019	76
3DD.003D2D2EFB	350	10/16/2018	Red Rock - NFSR	5/5/2019	9/26/2019	144
3DD.003D2D2EFF	335	10/16/2018	Red Rock - NFSR	4/18/2019	NA	-

Appendix B (continued)

Tag number	Length (mm)	Date tagged	Tag location (Salmon River sampling transect)	Entered NF	Exited NF	Duration in NF (days)
3DD.003D2D2F11	355	10/16/2018	Red Rock - NFSR	4/18/2019	8/10/2019	114
3DD.003D2D2F18	357	10/16/2018	Red Rock - NFSR	4/22/2019	NA	-
3DD.003D2D2F1E	300	10/16/2018	Red Rock - NFSR	5/3/2019	9/13/2019	133
3DD.003D2D2F21	348	10/16/2018	Red Rock - NFSR	4/28/2019	NA	-
3DD.003D2D2F8A	278	10/16/2018	Red Rock - NFSR	5/6/2019	NA	-
3DD.003D2D2F95	312	10/16/2018	Red Rock - NFSR	4/22/2019	NA	-
3DD.003D2D2F9E	285	10/16/2018	Red Rock - NFSR	5/4/2019	9/12/2019	131
3DD.003D2D2FA0	370	10/16/2018	Red Rock - NFSR	4/16/2019	NA	-
3DD.003D2D2FB2	326	10/16/2018	Red Rock - NFSR	5/7/2019	8/25/2019	110
3DD.003D2D2FB5	330	10/16/2018	Red Rock - NFSR	4/19/2019	NA	-
3DD.003D2D2FC6	367	10/16/2018	Red Rock - NFSR	4/20/2019	NA	-
3DD.003D2D312A	325	10/16/2018	Red Rock - NFSR	5/8/2019	8/22/2019	106
3DD.003D2D31E3	331	10/16/2018	Red Rock - NFSR	5/5/2019	6/8/2019	34
3DD.003D2D31E6	324	10/16/2018	Red Rock - NFSR	4/20/2019	NA	-
3DD.003D2D31ED	316	10/16/2018	Red Rock - NFSR	4/24/2019	NA	-
3DD.003D2D31EE	280	10/16/2018	Red Rock - NFSR	7/12/2019	7/15/2019	3
3DD.003D2D31F3	317	10/16/2018	Red Rock - NFSR	6/12/2019	8/24/2019	73
3DD.003D2D31F6	209	10/16/2018	Red Rock - NFSR	7/2/2019	8/20/2019	49
3DD.003D2D320A	267	10/16/2018	Red Rock - NFSR	7/17/2019	7/19/2019	2
3DD.003D2D320C	370	10/16/2018	Red Rock - NFSR	4/21/2019	9/2/2019	134
3DD.003D2D322F	320	10/16/2018	Red Rock - NFSR	5/4/2019	9/1/2019	120
3DD.003D2D323A	286	10/16/2018	Red Rock - NFSR	7/27/2019	9/23/2019	58
3DD.003D2D3242	298	10/16/2018	Red Rock - NFSR	4/24/2019	NA	-
3DD.003D2D2ED1	356	10/17/2018	Deadwater - Indianola	5/6/2019	8/28/2019	114
3DD.003D2D2EEA	316	10/17/2018	Deadwater - Indianola	4/21/2019	NA	-
3DD.003D2D2EF6	358	10/17/2018	Deadwater - Indianola	4/20/2019	7/21/2019	92
3DD.003D2D2F00	365	10/17/2018	Deadwater - Indianola	5/5/2019	8/22/2019	109

Appendix B (continued)

Tag number	Length (mm)	Date tagged	Tag location (Salmon River sampling transect)	Entered NF	Exited NF	Duration in NF (days)
3DD.003D2D2F9A	314	10/18/2018	Owl Creek – Copper Mine	5/9/2019	NA	-
3DD.003D2D2F88	365	10/22/2018	Morgan Bar - Red Rock	4/19/2019	7/25/2019	97
3DD.003D2D3056	374	10/22/2018	Morgan Bar - Red Rock	4/9/2019	6/19/2019	71

Appendix C. Transect, year established, coordinates (WGS 84: datum) and length for resident trout redd count transects in the Salmon Region.

		Start		End		
Stream name - Transect	Year established	Latitude (°N)	Longitude (°W)	Latitude (°N)	Longitude (°W)	Length (km)
		Rainbow Trout				
Big Springs Creek - Tyler	1994	44.70896	113.39917	44.72855	113.43430	3.4
Big Springs Creek - Neibaur	1994	44.70047	113.38436	44.70896	113.39917	4.5
Upper Lemhi River	1994	44.68689	113.36273	44.69945	113.37074	3.0
		Bull Trout				
Alpine Creek - upper	1998	43.90705	114.93078	43.90357	114.94457	1.5
Alpine Creek - lower	2010	43.89707	114.91327	43.90245	114.92246	1.5
Fishhook Creek - upper	1998	44.13706	114.96703	44.13472	114.97622	1.0
Fishhook Creek -lower	2008	44.14882	114.93716	44.13992	114.96205	3.5
Fourth of July Creek-older	2003	44.04112	114.75831	44.05039	114.69165	5.0
Fourth of July Creek-newer	2019	44.028734	114.80093	44.040377	114.75725	5.0
Big Timber (Rocky-Grove)	2007	44.548514	113.411215	44.520669	113.433544	3.6
Big Timber (Rocky Creek)	2007	44.520669	113.433544	44.529370	113.464150	2.7
Big Timber (Upper-Rocky)	2007	44.499120	113.461870	44.520669	113.433544	3.5
Hayden Creek	2010	44.70624	113.73430	44.37053	113.75771	2.5
Bear Valley Creek - upper	2007	44.78332	113.75496	44.79685	113.80820	4.7
Bear Valley Creek - lower	2002	44.77624	113.74259	44.78332	113.75496	1.7
East Fork Hayden Creek	2002	44.72984	113.67145	44.72438	113.66671	1.5

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